MILITARY SURGICAL MANUALS

NATIONAL RESEARCH COUNCIL

VOLUMES IN THIS SERIES

I. Manual of Standard Practice of Plastic and Maxillo-facial Surgery
II. Ophthalmology and Otolaryngology
III. Abdominal and Genito-urinary Injuries
IV. Orthopedic Subjects
V. Burns, Shock, Wound Healing, and Vascular Injuries
VI. Neurosurgery and Thoracic Surgery

FOREWORD

THE Medical Department of the Army has been confronted with the necessity for enormous and rapid expansion paralleling that of the armed forces. The state of war has greatly increased the task of furnishing adequate medical care for Army personnel since battle casualties are added to the already wide range of diseases and injuries that must be treated.

Expansion of the medical establishment of the Army is entirely dependent on entry into the service of individuals from civil life. While most reserve officers have had a varying amount of military training, practically all medical officers will encounter problems in the military service entirely foreign to their previous experiences. These problems are by no means confined to those of an administrative nature; many are distinctly professional. The military situation imposes certain restricting factors which render impracticable some procedures that would be considered ideal in civil life. The goal of furnishing the best possible treatment to all individuals is the same in the Army as in civil life, but the means to attain that goal may differ materially.

There has been a marked tendency to specialization within the medical profession since the first World War. This tendency is fundamentally sound but does serve to increase the problems of many individual medical officers in time of war. Specialization cannot be followed to the same degree in the military service as in civil life. While many highly qualified specialists in the various fields of medicine and surgery will serve in like capacities in the Army, this cannot invariably be true. The great burden of medical care will fall on medical officers outside the highly specialized fields. It is thus essential that nearly all medical officers be familiar with the principles of military surgery. Recent advances in therapy have resulted in radical modification of certain principles of treatment that were formerly considered sound.

This series of texts presents in compact form essential up-to-date and reliable information regarding military surgery. The various sections have been written by outstanding authorities in their respective fields. They have been prepared for publication under the auspices of the Division of Medical Sciences of the National Research Council.

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MANUAL OF STANDARD PRACTICE
of
PLASTIC AND MAXILLOFACIAL SURGERY

Prepared and Edited by the Subcommittee on Plastic and Maxillofacial Surgery of the Committee on Surgery of the Division of Medical Sciences of the National Research Council, and Representatives of the Medical Department, U. S. Army

ROBERT H. IVY, *Chairman*

JOHN STAIGE DAVIS — JOSEPH D. EBY

P. C. LOWERY — FERRIS SMITH

BRIG. GEN. LEIGH C. FAIRBANK, *Medical Department, U. S. Army*

LT. COL. ROY A. STOUT, *Dental Corps, U. S. Army*

With Contributions By

John Scudder — *Frederick P. Haugen*

Philadelphia & London

W. B. SAUNDERS COMPANY

1943

These texts will prove a highly valuable source of professional information for any surgeon desiring a knowledge of the principles of military surgery. Their application is not confined to military medicine, for most of the wounds and injuries of modern warfare may be duplicated in civil emergencies. The condensed form and avoidance of debatable points will render them very convenient for quick reference as well as for more mature study.

These volumes represent an important addition to the field of surgical texts. The individuals instrumental in their preparation have made a distinct contribution to civil and military medicine by their assemblage and presentation of this timely professional information.

JAMES C. MAGEE
Major General, U. S. Army
The Surgeon General

The naval medical officer is often faced with medical or surgical situations with which he must deal entirely alone and without the opportunity for consultation and assistance from other members of his profession. He may be the only medical man on a ship in the middle of an ocean, and any surgical emergency must be met by him and him alone. He cannot refer the case to a specialist; he himself must do everything that is necessary. It is important that he have the best assistance that professional books and journals can give him. A book such as this manual, which contains practical and essential things, readily accessible, is a real help to a medical officer and patient in this situation.

ROSS T. MCINTIRE
Rear Admiral, Medical Corps
Surgeon General, U. S. Navy

INTRODUCTION

THIS volume is one of a series developed under the auspices of the Division of Medical Sciences of the National Research Council to furnish the medical departments of the United States Army and Navy with compact presentations of necessary information in the field of military surgery. The individual manuals are prepared under the auspices of the various subcommittees of the Committee on Surgery of the Division of Medical Sciences of the National Research Council and are edited by the Committee on Information.

The first three volumes cover the following subjects: plastic and maxillofacial surgery; ophthalmology and otolaryngology; and abdominal and genito-urinary injuries. Succeeding volumes will contain material on the following: orthopedic subjects (ununited fractures, injuries of the spinal column, compound fractures, and osteomyelitis); burns, shock, wound healing, and vascular injuries; neurosurgery and thoracic surgery.

The Committee on Surgery includes Drs. Evarts A. Graham, Chairman, Irvin Abell, Donald C. Balfour, George E. Bennett, Warren H. Cole, Frederick A. Coller, Robert H. Ivy, Herman L. Kretschmer, Charles G. Mixter, Howard C. Naffziger, Alton Ochsner, I. S. Ravdin, and Allen O. Whipple. The Committee on Information includes Drs. Morris Fishbein, Chairman, J. J. Bloomfield, John F. Fulton, Richard M. Hewitt, Ira V. Hiscock, Sanford V. Larkey, and Robert N. Nye.

Most of the detail of the editorial work has been done by Dr. Richard M. Hewitt, head of the Division of Publications, the Mayo Clinic, Rochester, Minnesota.

LEWIS H. WEED, M.D., *Chairman, Division of Medical Sciences of the National Research Council*

MORRIS FISHBEIN, M.D., *Chairman, Committee on Information of the Division of Medical Sciences of the National Research Council*

CHARLES C. HILLMAN, *Brigadier General, U. S. Army; War Department Representative, National Research Council*

JAMES STEVENS SIMMONS, *Brigadier General, Army of the United States; War Department Representative, National Research Council*

CHARLES S. STEPHENSON, *Captain, U. S. Navy Medical Corps; Navy Department Representative, National Research Council*

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CONTENTS

SECTION I

RECONSTRUCTIVE SURGERY

CHAPTER XV

SECTION II

MAXILLARY SURGERY

CHAPTER XI

CHAPTER XII

SECTION III

MAXILLOFACIAL PROSTHESIS

CHAPTER XIII

SECTION IV

ANESTHETIC TECHNICS

CHAPTER XIV

SECTION I

RECONSTRUCTIVE SURGERY

Ferris Smith, M.D.

AUTHOR'S PREFACE TO SECTION I

THE purpose of this manual is directive. Haste in reconstructive surgery is made slowly; time is the friend of both the surgeon and the patient; judgment in planning and procedure derives not only from knowledge of sound basic principles, but also from experience.

The manual provides a standard of practice and accomplishment to aid the surgeon in the discharge of his duty to the casualty. The patient has a right to expect that the best in modern practice will be employed to expedite his comfortable recovery and restore his functions and appearance to the greatest attainable degree.

The accomplishment of such results depends on the intelligent cooperation—"team work"—of all services concerned, from the time the casualty leaves the field until he is discharged from the hospital. It must result from avoidance of many past mistakes—a recognition of both the good and the bad in literature and practice. The "don't's" throughout the text are as important as the things to be done.

This manual is also a guide. It is not intended to stifle the initiative or to limit the ingenuity of the surgeon. There are other methods that produce acceptable results, but such must be based on the principles outlined. *The surgeon should not be permitted to deviate from these standards unless his practice can be fully justified.*

It is desirable to express gratitude to several persons for their cooperation in the production of this text: to Carl Adams for the fine illustrations, to Josephine Miller for the excellent photography, and to Kathryn Richard for her splendid assistance in the editorial work. Acknowledged also with thanks is the generous permission of the following publishers and editors to use material from their texts and journals: Thomas Nelson and Sons: Reconstructive Surgery of Head and Neck, Ferris Smith. J. B. Lippincott Company: Annals of Surgery, V. P. Blair, Use of Live Tendon Strips in Cases of Facial Palsy, October, 1930. Surgery, Gynecology and Obstetrics: Blair and Byers, Paralysis of Lower Lid, February, 1940. The American Medical Association: Archives of Ophthalmology, V. P. Blair, Fascial Support of the Lid for the Correction of Ptosis, June, 1932.

FERRIS SMITH, M.D.

CHAPTER I

GENERAL CONSIDERATIONS

THE object of all real surgery is the restoration of a part to normal or as near to normal as possible. The "normal" includes not only *function* but also *cosmetic* condition. The very nature of most surgery requires maximal attention to the former and little, if any, concern about the latter. It is true, however, that surgeons dealing with exposed parts, particularly the head and neck, have striven for centuries to give that concern to cosmetic condition which it deserves.

The maxillofacial surgeon must constantly evaluate this dual responsibility, sometimes yielding something of the possible functional efficiency to desirable cosmetic results, and vice versa. At other times the question of function is not involved at all—the surgeon must undertake alteration of appearance for reasons equally important.

The casualty from the field of battle has a right to expect and demand the optimal result which can accrue from a highly cooperative professional service and a skill which results from the utilization of all that is best in the general and special experience related to his particular problem. His future mental comfort and success in the competition of living will be materially influenced by his facial function and appearance.

The desired results may be accomplished only by the understanding and cooperative effort of the entire professional personnel concerned from the moment that the casualty is taken up on the field until he is discharged from the hospital.

This guide is concerned with fundamentals—essentials to successful outcome—and with operative procedures which embrace the best of present knowledge and experience. These are not the only methods of accomplishing acceptable results. They are directive. They are published with the assumption that the surgeon will not deviate widely from the principles involved unless his end-result fully justifies such departure.

The "don't's" throughout the text are as essential as the things to be done. If shift from the indicative to the imperative mood will aid toward brevity or desired emphasis, the shift is made.

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The "don't's" throughout the text are as essential as the things to be done. If shift from the indicative to the imperative mood will aid toward brevity or desired emphasis, the shift is made.

"A thousand-mile journey begins with the first step." Not only does the surgical care of the casualty begin at the moment he is taken up on the field, but the *plan* of that care must begin to take form with his first aid. Each successive service rendered must contribute to, and in no wise subtract from, the end-result.

SIMPLE ESSENTIALS

Correlation and continuity of effort begin at the battalion station and follow through the hospital.

At Battalion Aid Station or Equivalent

1. Hemostasis.
2. Drugs by mouth.
3. Tetanus antitoxin.
4. Support tongue (mandible loss).
5. Furnish clear airway (tracheal trocar; rubber airway).
6. Remove tooth fragments, *free bone* (no attachment) and debris.

At Collecting Station (Ambulance) or Equivalent

1. Hemostasis.
2. Splints.
3. Support tongue (mandible loss).
4. Tracheal trocar (through cricothyroid membrane); airway.

At Clearing or Hospital Station or Equivalent

1. Anesthesia (local or general) (Section IV).
2. Hemostasis:
   (*a*) Pressure bandages (Fig. 170, *j*, *k*, *l*, *m*).
   (*b*) Locally—not in the course of the vessel.
   (*c*) Small hemostats.
   (*d*) Fine ligatures (No. 0 or 00).
3. For shock (p. 76):
   (*a*) Morphine.
   (*b*) Parenteral and intravenous fluids.
4. Support tongue (fracture, loss of mandible, and so forth) (Figs. 172, 178).
5. Splint broken bone fragments. *Do not* remove any bone fragment that has any remaining attachment.
6. Extra-oral traction appliances for support of collapsed tissues.
7. Tracheotomy.
8. Tetanus antitoxin.* Perfringens antitoxin.
9. Indicated drugs.

* Tetanus antitoxin not given if immunization has been effected by tetanus toxoid. See Circular Letters, Nos. 34 and 110, War Department, Office of the Surgeon General.

At Evacuation Hospital or Equivalent

The maxillofacial team, as such, has its first contact with the casualty at this point. Cooperation and consultation with the dental and reconstructive surgeons begin here and continue until the patient is discharged.

1. Manage shock (p. 79).
2. Anesthesia (Section IV):
   (*a*) Local anesthesia is desirable and adequate in most instances. The substances employed are pentobarbital sodium (1½ to 3 grains or 0.1 to 0.2 gm.) and procaine (0.5 per cent) containing 15 minims of epinephrine to the ounce (30 cc.); this quantity not to be exceeded, used for block or infiltration. The latter controls capillary bleeding and surface oozing to a large degree.
   (*b*) General anesthesia: inhalation, intratracheal, intravenous, or rectal, as desired.
3. Hemostasis:
   (*a*) The tissues should be carefully handled with sharp hooks and sponged gently. Use a suction pipet if one is available.
   (*b*) Use small hemostats and fine ligatures. Include minimal amounts of tissue in the ligatures. Employ high-frequency coagulation for small vessels and weeping surfaces, if this equipment is available. All of this minimizes shock and promotes rapid healing.
   (c) Ligate locally and not in the course of the vessel, if possible. Maximal blood supply is needed in the repair of the area.
4. Cleanse the area thoroughly with soap, water, and gauze. Investigate all tracts. Flush with saline solution.
   Use débridement judiciously but thoroughly, conserving all essential structures.
   Soak with 3 per cent iodine or merthiolate (acetone solution).
5. Reduce fracture. Immobilization (see "Maxillary Wiring," pp. 272, 291). *Conserve all bone* and fix in place.

Approximate carefully the lining to the skin with fine sutures properly tied (p. 27). Immediate closure reduces the probability of infection, results in less scar and distortion and, consequently, easier and better reconstruction. This statement applies to patients receiving care within six hours after injury.

6. Place a small "cigarette cover" as a drain.
7. Perfringens antitoxin.

8. Alcohol dressing (70 per cent).
9. Indicated splinting and bandaging for comfortable transportation.
10. Transfusion, as indicated (p. 80).

At General Hospital during Period of Incubation of Infection (Five to Ten Days)

1. Appropriate supportive treatment: blood, saline solution, ferrous sulfate, liver, vitamins.
2. At first evidence of local inflammation:
   (*a*) Immobilization of soft parts and bone (splinting and proper bandaging). Physiologic rest.
   (*b*) Moist heat: saline or magnesium sulfate solution with sodium chloride. A "pinch" of sodium chloride added to the magnesium sulfate solution serves as a catalyzer to improve materially its action.
   (*c*) Chemotherapy. Give sulfonamide drugs empirically until a culture establishes the type of infection. Add an equal amount of sodium bicarbonate and maintain a minimal intake of 3000 cc. of fluid daily. Concentration in the the blood, blood destruction, and the urine must be determined frequently. Chemotherapy is not effective in the presence of *suppuration without drainage* because of the relatively large amounts of peptone resulting from tissue destruction.
   (*d*) Roentgen therapy. Its value probably results from histiocytic stimulation.
   (*e*) Transfusion. This is supportive and required because of the destruction by hemolytic organisms and drugs.
3. At first evidence of secretion:
   (*a*) Culture and select drugs accordingly.
   (*b*) Conservative, but adequate, drainage.
   (*c*) Continue moist dressings.

A proper period should elapse following the cessation of drainage before any *surgery* is undertaken.

Latent Infection

Appropriate drug may be used prophylactically when surgery is undertaken.

4. Deep infections of the tongue and neck should be anticipated and dealt with promptly (p. 83).

At General Hospital during Period of Reconstruction

1. Consultation with, and cooperation of, plastic and dental surgeons in planning and reconstruction in all cases wherein the jaws and bony framework of the face are involved.
2. Appraisal of the total lesion and loss.

A proper appreciation of the nature and *extent of the loss* and disability is vital to the success of its repair. This involves the skin covering, supporting structure, glands and ducts, motor nerves, and lining tissues. The remainder of the material on reconstruction will begin on page 14. There is a reason for a digression at this point.

EXAMPLES OF INJURIES

The following examples of various injuries (Fig. 1) are interposed here to aid the surgeon in his understanding of the subsequent discussions. It is suggested that he appraise the losses in each instance, plan the various phases and stages of reconstruction and, finally, consult the relevant text for the methods employed.

There is no fixed formula for reconstruction in many cases. It requires a clear imaginative picture of each procedure and stage, ingenuity, the ability to improvise at the moment, and a clear knowledge of principles involved to accomplish routinely satisfactory results. The desirable methods of reconstruction of the lip offer a limited choice of procedure. This limitation is imposed, primarily, by the desire to conserve and *improve function*. The *cosmetic result* is an important secondary consideration. Both objectives are attained by rational, sane choice of procedure.

Undesirable Procedures

Few, if any, of the operations described in texts, for large partial or total lip reconstruction, should ever be employed. This radical statement is readily defended. Practically all of these operations contemplate the use of full-thickness cheek flaps which are cut without regard for the muscles of expression about the mouth, or for the blood and nerve supply. The muscle included in these flaps atrophies in most instances and supplies only a scar filling which is without function. It is never necessary to cut into the musculature about the defect in order to effect a repair.

Such operations as those of *Szymanowski* (Fig. 2) are extremely destructive of function and cannot possibly produce a pleasing cosmetic result. The procedure pictured in Fig. 2, A, for the reconstruction of both lips was never accomplished on a living patient. The in-

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   (*e*) Transfusion. This is supportive and required because of the destruction by hemolytic organisms and drugs.
3. At first evidence of secretion:
   (*a*) Culture and select drugs accordingly.
   (*b*) Conservative, but adequate, drainage.
   (*c*) Continue moist dressings.

A proper period should elapse following the cessation of drainage before any *surgery* is undertaken.

Latent Infection

Appropriate drug may be used prophylactically when surgery is undertaken.

4. Deep infections of the tongue and neck should be anticipated and dealt with promptly (p. 83).









Fig. 1.—*e, f, g, g,* Examples of facial injuries.



Fig. 1.—*a*, *b*, *c*, *d*, Examples of facial injuries.



Fig. 1.—*k*, *k*, *l*, *l*, Examples of facial injuries.

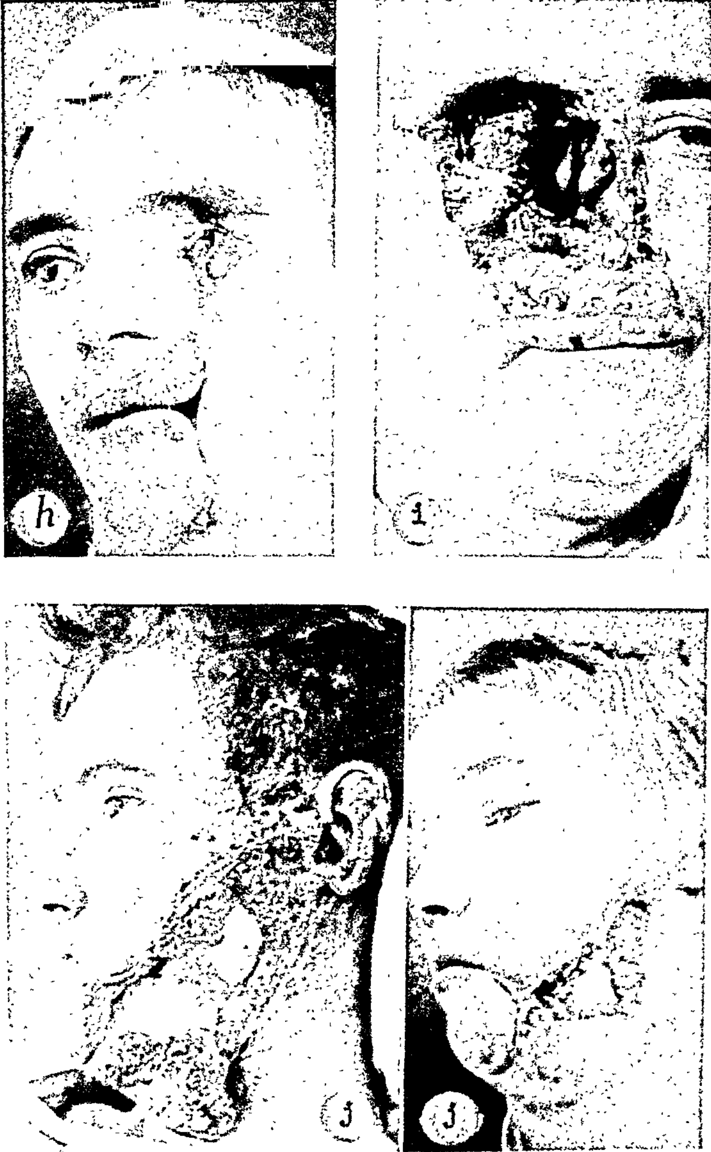


Fig. 1.—*h*, *i*, *j*, *j*, Examples of facial injuries.

cisions outlining flaps b and d completely sever the blood and nerve supplies. The lateral incision to create the opening of the mouth between b and d leaves a narrow island of tissue to nourish the entire triangular flap b. The end-result, if such could be obtained, would be a crippling functional and cosmetic disability.

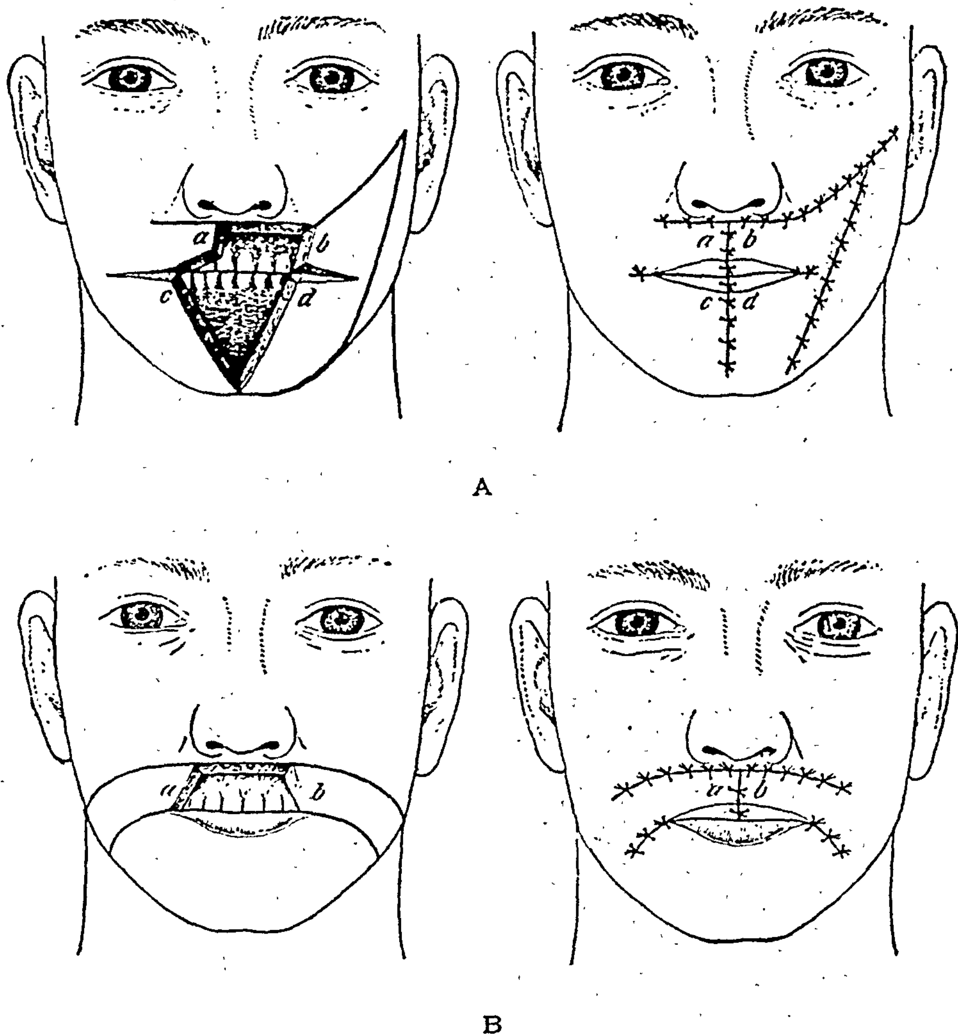


Fig. 2.—A, Restoration of both lips (Szymanowski); B, restoration of the upper lip (Szymanowski).

The procedure pictured in Fig. 2, B, is possible of attainment from the standpoint of blood supply, inasmuch as the proposed flap contains the transverse facial artery and the remainder of the superior labial artery. The pictured incisions cut off the inferior labial artery on both sides. The incision completely severs all muscles of expression, except the depressors, about the angles of the mouth. A patient suffering this procedure has been seen within recent months. He pre-

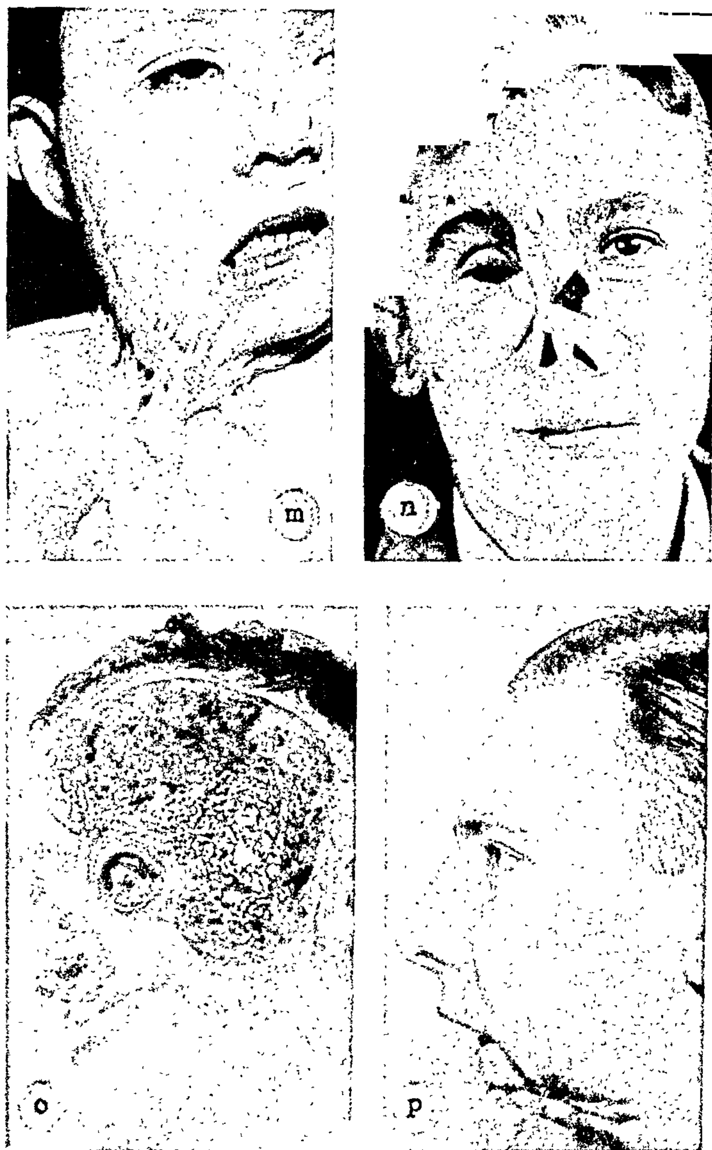


Fig. 1.—*m, n, o, p,* Examples of facial injuries.

tion. His object is a dual one: not only is he interested in the restoration of function and normal appearance, but he must also be scrupulously concerned with the *safety* and *comfort* of his patient. He must see clearly where each step in the procedure leads. This demands a careful consideration of available material of a desirable quality, its blood supply, its mode of transference, essential prosthetic aids, and the location of ultimate scars. Two general types of flaps must be considered: (1) French, or sliding, flap; (2) interpolated flap.

Skin Covering

French or Sliding Flap (Fig. 4).—This method has a very limited use when employed alone. This flap is "slid" or advanced from its original bed with little twisting or torsion of its pedicle. It is widely used alone for the repair of small defects and, combined with other

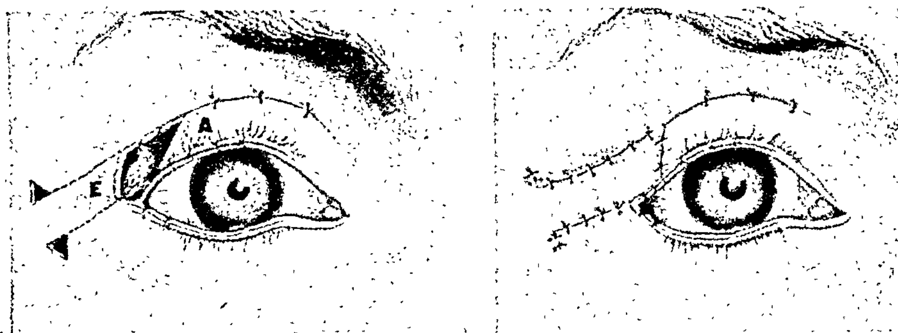


Fig. 4.—French or "sliding" flap. *Left,* in process; *right,* complete. The significance of the letters on the face of the illustration is evident in Fig. 138, with part of which Fig. 4 is identical.

types, is essential to the repair of defects in all parts of the body. It is useful only in masking a loss of surface tissue and should never be used in repair of large partial or total losses (muscle, supporting tissue, lining) because rapid scar contraction and deformity result. Its successful use in the repair of a cavity always demands a *lining* of mucous membrane or skin.

Interpolated Flap.—This is the requisite method for repair of all major lesions. Several methods of obtaining tissue for interpolation may be defined.

Flaps from Immediate Neighborhood.—Such flaps are single or double, with a pedicle which is rotated, twisted, bridged, or tunneled (Fig. 5; see also Figs. 71, 72, 75, 107, 108, 110). This is the *Indian* mutilation type of flap. The pure Indian type of flap was raised from the forehead, rotated on a pedicle, and used without lining for nasal repair. This flap is a method of choice for large partial

sented a tight upper lip and a depressed scar band dividing each cheek.

The operation of *Sedillot* (Fig. 3, A) completely destroys the muscles of expression. The distal ends of the outlined flaps might acquire sufficient blood supply from the transverse facial artery, which is included in its base, but this is questionable. The procedure could result only in a distorted orifice without expression, the sole function of which would consist of a rigid curtain, closing and masking a defect.

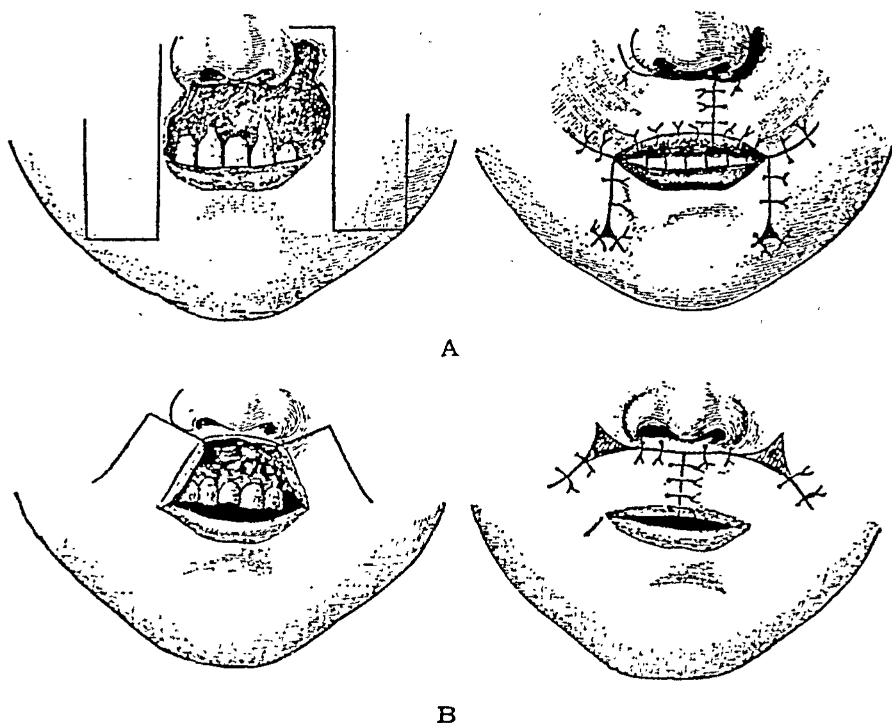


Fig. 3.—A, Sedillot's operation; B, Brun's operation.

The procedure of *Brun* (Fig. 3, B) has only one sound feature: the flap is cut in the direction of the blood supply. It has no regard for the levators of the angle of the mouth and the zygomaticus muscle.

Now to return, as the reader was promised we should do, to the matter of reconstruction.

PLANNING RECONSTRUCTION IN GENERAL

Appraisal of Method

The planning of the repair in a given case involves many things. Having determined the approximate loss of the several tissue elements concerned, the surgeon must consider methods of reconstruc-

Fig. 8.



Fig. 9.





Fig. 10.

Fig. 8.—Modification of Italian method. Tubed arm pedicle to the nose (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

Fig. 9.—Modification of Italian method. Tubed pedicle flap from abdomen to wrist. The arm is to serve as a carrier.

Fig. 10.—Modification of Italian method. Tubed arm pedicle to the face (Smith's method of fixation) (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

the raw edges of a long, rectangular pedicle, thus doing away with the danger of infection by including the raw surface and furnishing a certain blood supply to a flap at its distal end.

or total nasal covering and, rarely, a method of necessity in covering large losses of the cheeks and lips.

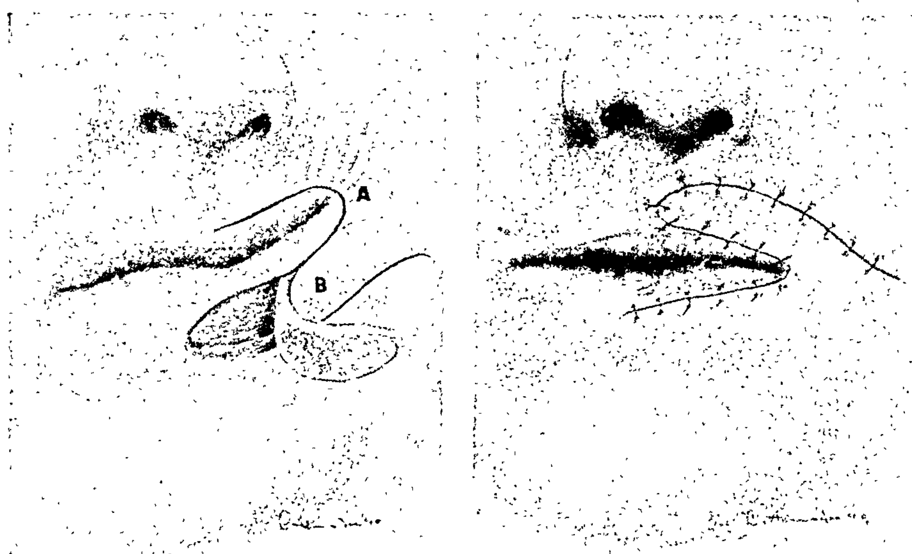


Fig. 5.—Interpolated (rotated) flap. *Left,* in process; *right,* complete. The significance of the letters on the face of the illustration is evident in Fig. 65, with part of which Fig. 5 is identical.



Fig. 6.



Fig. 7.

Fig. 6.—Outline of rectangular flap preparatory to tubing and folding.
Fig. 7.—Tubed pedicle and flap.

FLAPS FROM DISTANCE WITH TUBED PEDICLE (Figs. 6, 7, 8, 9, 10; see also Figs. 78, 81).—"Tubing of the pedicle" consists in suturing

tissue at intervals of two or three weeks until the blood supply is adequate, when the pedicle is turned or twisted, as required.

The flap must be returned to its bed if there is the slightest evidence of ischemia. The flap in Fig. 7 was elevated and delayed six times over a period of five months before it could be safely utilized.

Free Flaps or Grafts.—The skin for the repair of large defects of the cheeks, nose, chin, and so forth, may be supplied by a nonpedicled, full-thickness skin flap or by thick, split skin (0.016 to 0.020 inch or 0.04064 to 0.0508 cm.). These flaps may be applied with such certainty of success that factors other than growth determine the choice (p. 55).

FLAPS OF CHOICE.—In all cases of loss of the full thickness of the cheek and adjacent lips, the pedicled flap becomes the procedure of necessity.

The tissue for the repair of lips only generally comes from the immediate vicinity of the defect.

One is never warranted in the use of a *forehead flap* to repair a minor nasal loss. Defects of the upper half or two-thirds of the nose are simply and perfectly repaired by a *tunneled flap* after the technic of Monk (Fig. 104). The loss may be repaired by turning lining flaps from the border of the defect and covering with a free full-thickness graft, when the frontalis artery is not available (Figs. 94, 96, 101). Larger partial or total losses are best repaired with a *scalp flap* which includes the frontalis and supra-orbital arteries in its pedicle. The lining may be turned in from the sides of the defect, may be obtained from the pedicled flap itself, or may result from a graft on the raw surface of the flap before it is shifted from the forehead (Figs. 98, 103, 107, 108, 110, 111).

Total and partial losses of the eyelids may be reconstructed variously (see "Blepharoplasty," p. 175).

The planning, preparation, and transference of these flaps constitute the prime requisites for success, while intelligent, judicious aftercare determines the outcome of the effort. There are no absolute rules in this type of surgery; circumstances peculiar to each case determine the management, and the very things to which we object in selecting a routine method may become not only the procedure of choice, but a necessity. The ultimate appearance of these flaps is determined by the kindly influence of time and the faithfulness of the surgeon in his attention to small detail.

Lining Tissues.—Lining tissue for the cheeks, lips, nose, and occasionally for the eyelids is supplied by skin introduced either as a hinged, rotated, tunneled, or pedicled flap or as a free graft, variously

The base, *source of blood supply,* is so located that the distal flap can be transferred without undue twisting or tension of the tube pedicle, which would jeopardize its viability. The patient's comfort, during the period of three weeks that the pedicle remains attached, must be considered (Figs. 8, 9). *Perthe's method* of outlining, dissecting, and resuturing the flap in its original bed is usually combined with this procedure.

FLAPS TRANSFERRED ON "CARRIER."—Usually the carrier in this method is the arm. This is essentially the *Italian method,* which was primarily proposed for rhinoplasty. It consists in fashioning a flap on the arm and later transferring it to the nose with the arm immobilized on the head until new blood supply is established.

In the light of present knowledge, the *original Italian method* has nothing to recommend it in facial repair, and many things to condemn it. The position is torture to the patient, there is danger of emboli in the superficial veins of the arm, infection occurs readily from contact with the nose, and dressings are difficult. On the contrary, we feel that the arm furnishes the best source of skin in a large percentage of cases and urge this method, *with proper modifications* of the position of the arm and management of the flap, as the *method of choice* in the majority of cases (Figs. 8, 9, 10).

Flaps may be tubed at a distance (abdomen), attached to the hand or lower forearm, and transferred with the arm in a comfortable, safe position during the period when adequate blood supply is being established (Fig. 9; see also Fig. 168).

Tubes may be fashioned at a distance (abdomen, back, and so on) and advanced caterpillar-fashion to the vicinity of the defect (Fig. 160). The tube is constructed and allowed to heal for three weeks. The distal attachment is then advanced as far as possible without kinking and is sutured in a defect created by incising and elevating a small, semicircular skin flap. Three weeks later, when the recently transplanted end has acquired a sufficient blood supply to nourish the tube, the proximal end is excised and advanced to the limit of the tube. The process is continued until the tube is attached to the margin of the lesion. It is finally dissected flat, and the skin is utilized in the repair. The procedure is *rarely* necessary.

"DELAYED FLAPS."—Flaps of either the sliding or the interpolated type must not be removed from their origin until an adequate blood supply has been assured. This applies particularly to interpolated flaps, which, of necessity, often are cut against or across the direction of blood supply.

They must be partially or totally raised from the surrounding

the jaws, the clavicle, and the crest of the ilium. The cortical bone of the ribs and tibia does not offer the desirable quality of the cancellous bone of the iliac crest (p. 307). Bone from the iliac crest is obtained



Fig. 11.



Fig. 12.

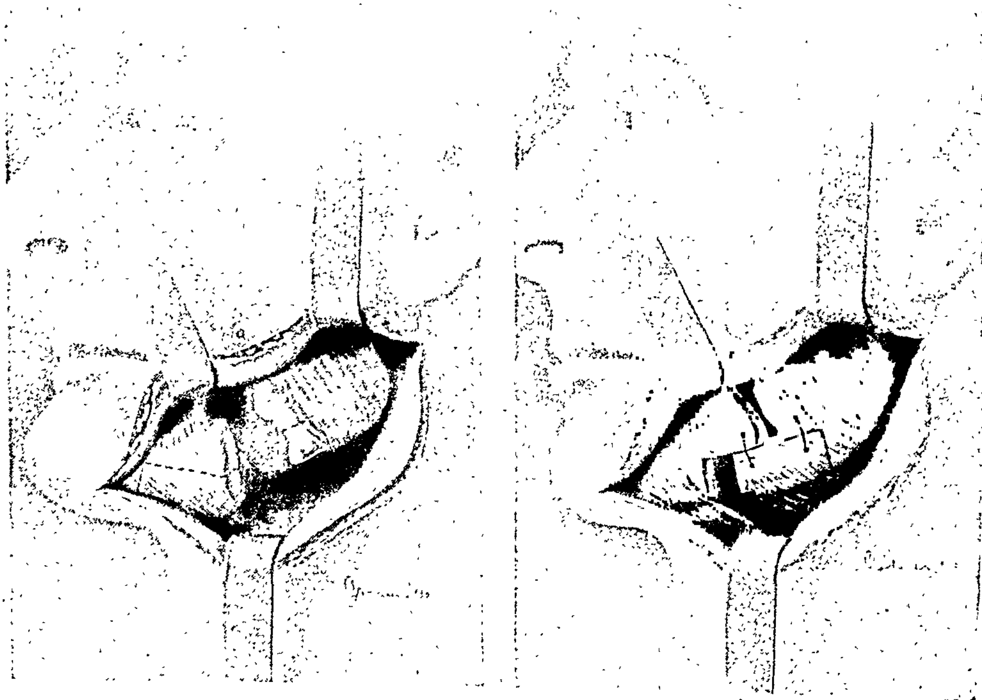


Fig. 13.

Fig. 11.—Block bone graft in the mandible.
Fig. 12.—Osteoperiosteal graft in the mandible (see p. 303).
Fig. 13.—Diagram of sliding pedicle graft (mandible).

with less discomfort and shorter disability than sections of rib and tibia. It can be readily fashioned in situ and transplanted with minimal handling. It is the source of choice.

applied. The free graft may be applied to the covering flap before it is transferred from its origin or on a temporary prothesis which is either sutured (Esser inlay) in position or retained mechanically by a device or a dressing (Figs. 76, 78, 81, 96, 107, 111).

The lining tissue for an eyelid is preferably obtained from another eyelid or from the buccal mucosa. The use of thin skin is sometimes a necessity. The epithelium undergoes metaplastic changes adapting it to its new environment (Figs. 143, 146).

Bone, One of the Supporting Tissues

Free or "Block" Grafts.—These are solid pieces of cortical or cancellous bone which are either fashioned in situ to the desired shape with the chisel, saw, and drill or so removed and shaped in a sterile vise on a sidetable. Blocks may be removed from the tibia readily and quickly with a motor-driven double saw. This type of graft is commonly employed (Fig. 11 and p. 307).

Sliding Grafts.—These are blocks of bone with the periosteum and soft parts attached, removed from the border of the defect. They are "slid" across the defect to abut on the opposite fragment. Such grafts are obtainable and useful in repairs of the jaws and hard palate (Fig. 13).

Pedicle Grafts.—This graft may be obtained from the clavicle by fashioning a tubed pedicle on the neck, with its base near the angle of the jaw and its distal flap comprised of the soft parts covering the clavicle. The "block" of clavicle is removed without disturbing its periosteal attachment to the flap. This type of graft is occasionally useful in repairing a large loss of jaw and soft, covering tissue. Such a loss requires a lining turned in from its borders or obtained by folding the skin of the distal flap around the bone block.

Osteoperiosteal Grafts.—These are thin plates, or shavings, of cortical bone attached to periosteum. These grafts are commonly cut from the flat surface of the tibia. They may be taken to the full width of this surface and to any useful length (Fig. 12, A, and p. 303).

The soft parts are reflected from the bone without disturbing the periosteum. The periosteum is incised and slightly separated about the borders of the desired graft. The bone along this line is grooved to a depth of 1 mm. with a chisel or a motor saw, and a shaving of bone of approximately this thickness removed with a broad, sharp chisel.

Sources of Bone.—Do not use homologous or heterogeneous bone. The use of pieces of "soup bone" is not justified in any manner. The patient has an adequate supply of bone (autogenous) for all purposes.

Block grafts can be obtained from the ribs, the long bones (tibia).

2. Place the cartilage in a solution consisting of: 1 part aqueous merthiolate and 4 parts physiologic saline solution.
3. Change the solution on the following day, again three days later and, after that, once a week.
4. Store in small, sterile jars in a cool place.

Fat; Fascia

Fat has little use as a free transplant. The fact that the amount of absorption is unpredictable precludes its use as a filler for depressed contours. It is extremely useful when shifted locally and with attachment to prevent the adhesion of a suture-line scar to underlying soft tissue or bone, or both, and when it is transferred with a pedicled flap to cover tendons and muscles. It may be used successfully in this manner as a filler to restore contour.

Fascia has its principal use as a strong, nonabsorbable, nonadhering, and nonelastic supporting material. It is employed chiefly for support and fixation in the mechanical balancing necessary in cases of unilateral facial palsy. It is obtained from the fascia lata by the use of stripping instruments introduced through a small skin incision which permit the cutting of strips the entire length of the thigh (Fig. 14).

The incision, 2½ inches (about 6 cm.) long, is made above the knee and the fascia cleaned of fat as high as possible. A strip of the desired width is engaged as low as possible and cut up to the tensor fasciae latae. Three or four pieces of fascia of the required lengths are removed in this manner.

Dermal Graft

This is the most useful transplant for correction of the contour of nonrigid regions (nose, eyelids, face, lips, and supra-orbital region). The graft is easily obtained and transplanted. It can be cut to the desired shape and planted in double layers. The procedure may be repeated as often as necessary to obtain a perfect restoration. The graft organizes into scar which remains flexible (lower half of nose, sunken eyelids following trophic absorption of orbital fat, and so forth). It rarely gives trouble. This is occasioned by sebaceous cysts which form in undegenerated glands. These may be dealt with readily.

The desired skin is outlined on the abdomen, thigh, or arm, and its epithelium shaved off with a skin-graft knife or razor (thick Thiersch graft). The remaining corium is dissected free from fat. This graft, or two layers of it as required, is introduced into a tunnel prepared under the skin through a small neighboring incision. A stout

Commonly *osteoperiosteal grafts* are obtained from the tibia as described above.

Application of Bone Grafts.—A *block graft* may be (1) inserted between the freshened ends of the defect and fixed by the soft parts, a splint, and dressing; (2) wired to the bone with which it is in contact; (3) mortised and bone-pegged; or (4) lapped and wired or pegged. This graft is commonly fixed by wiring with silver or noncorrosive wire. The *wire must be removed* after satisfactory union has been obtained.

An *osteoperiosteal graft* may be variously applied: (1) A single layer, periosteal surface external, may be applied to the freshened surfaces of the ends of the defect and held in position with catgut passed around the mandible. (2) A double graft, periosteal surfaces external and internal, may be similarly applied. (3) Small incisions may be made over the margins of the defect to permit freshening of the bone surfaces, the soft tissue intervening between the two incisions *tunneled,* and the graft slid into position (jaw, skull, orbit, and so on). This third method of management is very useful in repairing the ascending ramus of the mandible through a single opening at the angle. It is also serviceable for repairing defects in the skull. The bone acquires a size and a strength to meet the requirements imposed on it (Wolff's law). Experience proves that grafts should not be fixed too rigidly nor too long. Callus forms and organization occurs more rapidly in the presence of slight motion and irritation.

Cartilage, One of the Supporting Tissues

This is the material of choice for nasal support, reconstructions of the auricle, and certain restorations of contour about the face, orbit, and supra-orbital region. It is useful for protection in small losses of the skull. Cartilage does not unite with bone. It is encapsulated in scar and, as a rule, remains unchanged if the perichondrium is removed.

Both *autogenous* (same person) and *homologous* (same species) cartilage is usable. Autogenous cartilage is obtained from the free and fixed ribs for ordinary use and from the ear itself for otoplastic procedures. A sufficient use of homologous cartilage has proved its viability and safety. The ease of its procurement, preparation, and storage almost prohibits opening of the patient's chest to obtain autogenous material. It is gathered in the morgue under aseptic conditions from subjects who have met with traumatic fatalities and who were free from infection. The cartilage is preserved as follows:

1. Remove carefully all of the perichondrium.

2. Place the cartilage in a solution consisting of: 1 part aqueous merthiolate and 4 parts physiologic saline solution.
3. Change the solution on the following day, again three days later and, after that, once a week.
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suture (dermal), threaded into a long needle on each end, is passed through two end-corners of the graft. The needle is introduced beneath the tunneled skin and brought through it at appropriate points at the distal end of the tunnel. The graft is drawn into the tunnel, and the threads are removed. The skin incision is closed, and a firm, gauze dressing applied over the area. This is maintained for several days until adhesion and nourishment of the graft are assured (Fig. 15).

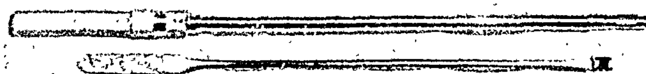


Fig. 14.—Fascial strippers.

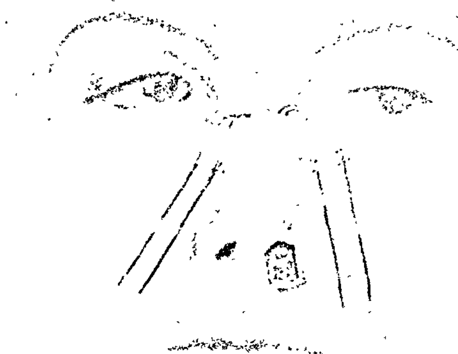


Fig. 15.—Method of introduction of a dermal graft.

Absorption of 10 per cent to 20 per cent in volume should be anticipated.

Prosthesis

Various types of prosthesis (Chap. XIII) are temporarily essential in certain large reconstructions, including supporting bone and soft parts. They furnish a necessary scaffold to support soft tissue and prevent contraction pending the final introduction of bone and cartilage. They are particularly useful in reconstruction if latent infection probably exists which would menace bone and cartilage introduced at this stage. They are necessary for the introduction and application of skin grafts in the orbit, buccal mucosa, and intranasally.

It is rare that loss is so extensive that it cannot be repaired with the patient's tissues and without the permanent use of foreign bodies. Such a result is not only desired but expected.

Prosthetic pieces must never be left in soft tissues permanently. This applies to all foreign substances such as ivory, celluloid, metals, and so forth.

Preparation of Field

Infection is the greatest enemy to all fine plastic results and in some procedures absolutely prohibitive of any desired result. The preparation of the field cannot be too scrupulous.

For prophylaxis, order *sulfonamide drugs* or other indicated drugs in the presence of latent infection.

The site for removal of a flap from the *arm, chest,* or *abdomen* is shaved and scrubbed with green soap, gauze, and water. A soap poultice is applied to the area for several hours. This is removed in the operating room and the part thoroughly cleansed with ether and alcohol. It is then painted with a 3 per cent solution of iodine. This is removed with alcohol. Recently burned areas may not tolerate irritating substances (iodine, mercurials, and so forth). Thorough cleansing with soap and gauze, ether and alcohol, must suffice in these cases.

Preparation of the *face* varies somewhat. The day previous to operation the face is steamed and thoroughly cleansed with soap and water. The face is sponged in the operating room with ether and is painted with 3 per cent iodine solution. This is allowed to dry and is then removed with alcohol.

The *nose* is prepared carefully for rhinoplasty (p. 139). All hair is clipped from the nostrils. The interior is sprayed with a 1:2000 solution of *epinephrine hydrochloride* containing 10 per cent of *cocaine.* Following anesthesia, the vestibule is thoroughly cleansed with ether and alcohol and is packed with gauze saturated with 70 per cent alcohol. These packs are finally pushed beyond the area of incision, and the vestibule is painted with 3 per cent tincture of iodine.

The sterile drapes about the field are fixed in place with "surgical glue."

Choice of Anesthesia

Most plastic procedures about the face and neck can be very satisfactorily performed under local anesthesia. This can be produced either by infiltration or by nerve blocking.

We find a 0.5 per cent solution of *procaine,* containing 15 to 20

minims of *epinephrine hydrochloride* to the ounce (30 cc.), highly satisfactory. It is rarely necessary to use the entire ounce of solution. If more is required, it is used without epinephrine. Not only is satisfactory anesthesia obtained, but ischemia is produced, which facilitates accurate work and greatly minimizes the time required to obtain a dry field before dressings are applied.

The procaine is preceded by *pentobarbital sodium* (nembutal) by mouth, 1½ to 3 grains (0.1 to 0.2 gm.), a half hour before operation and supplemented by *morphine*, if required.

The interior of the nose is anesthetized, in some rhinoplastic procedures, with a solution consisting of 10 per cent *cocaine* in a 1:2000 solution of *epinephrine hydrochloride.* This is applied on cotton pledgets. Anesthesia, without ischemia, can be obtained by application at two points. A cotton-tipped applicator, which has been dipped in epinephrine hydrochloride (1:1000) and rubbed in cocaine powder, is inserted between the midpoint of the middle turbinate and the septum, against the cribriform plate (anterior ethmoidal nerve). A second applicator is inserted upward and backward, diagonally across the middle turbinate, against the anterior wall of the sphenoid bone and the lateral walls (sphenopalatine ganglion). The use of local anesthesia does not materially affect healing in the region of operation.

Certain types of patients, as well as certain types of surgical procedure, are best handled under general anesthesia. There can be no fixed rule on this subject. Just as each case in which plastic surgery is employed constitutes an individual problem which cannot be solved by a fixed formula, so the choice of anesthetic must be suited to all the conditions of temperament and surgical requirement. Tribromethyl alcohol (avertin) by rectum, preparations for intravenous use, intratracheal ether and nitrous oxide, and so forth all must be considered. (For more on anesthetic procedures, see Section IV.)

Incisions

A clean incision at a right angle to the skin surface made with a sharp knife and minimal trauma is the most satisfactory. If the wound is carefully approximated with slight eversion of the skin edges, the best result is obtainable. Beveled incisions have been periodically advocated for many years. They are difficult to approximate accurately and have only theory, with nothing in fact, to recommend them.

Handling Tissue

Rough handling of tissue contributes to shock and materially affects the time of healing and the end-result.

1. Use fine hemostats (mosquito type).
2. Include the smallest possible amount of tissue with the bleeding point.
3. Use the finest ligatures compatible with the procedure.
4. Do not repeatedly use *tissue forceps* with sharp, coarse teeth.
5. Handle all tissues with sharp hooks whenever possible.
6. Sponge gently. Do not wipe; use gentle pressure.
7. Utilize a suction pipet when one is available.

Sutures and Closure

Horsehair is the ideal suture for fine skin closure. It possesses considerable tensile strength, elasticity, and no capillarity. It can be obtained in many sizes, ranging from very fine to fairly coarse strands. The increasing difficulty in procurement limits its use. A Nylon suture appears to possess the same qualities and may be substituted for it. Davis and Geck have produced a fine dermal suture, fixed on an atraumatic needle, in size ranges as small as 8–0. It is perfect, except for the absence of elasticity. Allowance for this may be made in tying. Many surgeons prefer silk. The prepared material possesses all of the qualities of hair, except elasticity. The type of suture material employed is not vital to success, if its qualities are appreciated.

The method of using the stitch—the closure—is of much greater importance than the suture material. It is important that the closure be effected *without excessive stitch tension.* This can be accomplished by free undercutting of the edges, the use of relaxation stitches in the undersurface of the skin and underlying tissues, and the use of relaxation devices on the skin surface.

Relaxation Procedures.—Several methods of obtaining proper relaxation are useful for this work. If the defect is small, a few interrupted catgut sutures passed through the deep layers of the skin or subcutaneous tissue about ¼ inch (about 0.6 cm.) from the wound margins serve the purpose. If it is desirable to use and to remove the tension sutures, or if a somewhat larger defect is to be closed, the method of *R. L. Dickinson* is useful (Fig. 16). Silkworm-gut or dermal suture is passed as illustrated in the diagram and tied over rubber tubing, a glass rod, or a gauze roll.

The *Lane* stay suture is ideal for relaxation and approximation of the muscle and mucous membrane in the lips and cheeks. It provides firm coaptation of these tissues and, because its *long residence without visible scar* is possible, furnishes a perfect protection against separation or stretching until organization of the wound is completed.

Blair's substitute for this stitch is simple and efficient (Fig. 17). It can be further modified to eliminate the skin entirely (Fig. 18).

Closure of Large Defects.—The closure of large defects, such as result from the removal of pedicled flaps from the arms, requires

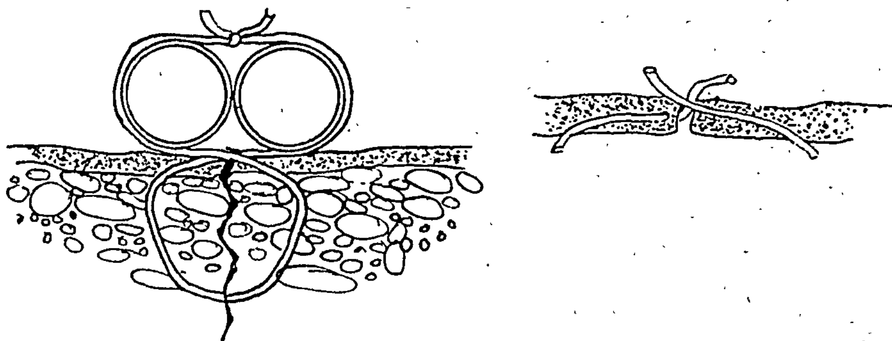


Fig. 16.—Removable tension suture which does not produce cutaneous scar (Dickinson).

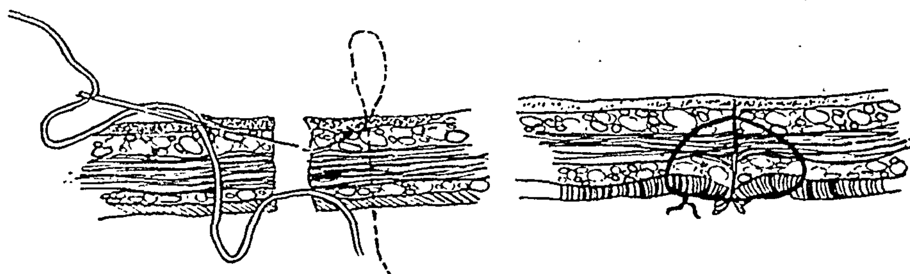


Fig. 17.—Modified Lane stitch; application to lips and cheek (Blair). *Left,* making of the stitch; *right,* complete.

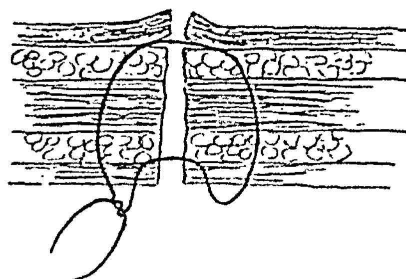


Fig. 18.—Modified Lane stitch.

extensive undercutting of the skin and powerful traction. I routinely use the *Halsted* breast stitch, which has been commonly described as the "far-near-near-far" stitch. A long strand of No. 2 chromic catgut is employed. It is first passed through the subcutaneous tissue, so as *not to include the skin,* about 2 inches (about 5 cm.) from the wound

margin on one side; then it similarly is passed about ½ inch (about 1 cm.) from the wound edge on the opposite side, then it is passed in the same location on the first side, and finally it is passed about 2 inches from the margin of the opposite side in the same manner as first described. Two such stitches properly placed in a defect 4 to 6 inches (about 10 to 15 cm.) long and 3 inches (about 7.5 cm.) wide allow sufficient traction to complete a closure. Frequently a small, cir-

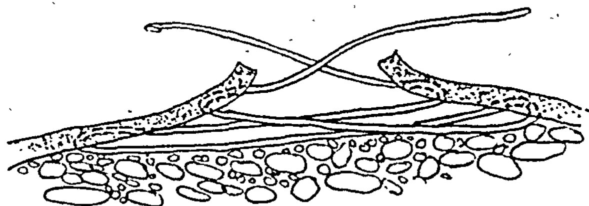


Fig. 19.—Strong traction stitch for closure of large skin openings (Halsted).

cular slough is observed about the deep insertions of this stitch. This results from a strangled blood supply following the strong traction. If redness appears at this point, the suture should be cut where it passes beneath the skin edges. The stitch has largely served its purpose by the third day, and such cutting does not, as a rule, impair the result (Fig. 19).

Two other sutures that can be used for approximation are shown in Figs. 20 and 21.

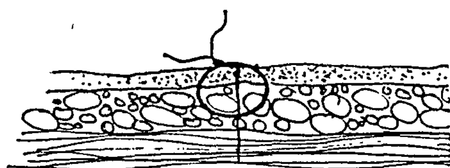


Fig. 20.

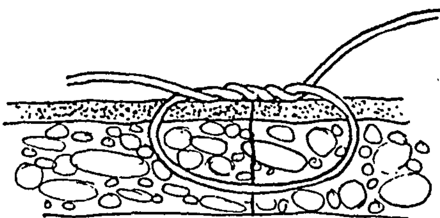


Fig. 21.

Fig. 20.—Simple approximation suture (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons.)
Fig. 21.—Double-twist knot (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

Relaxation without Sutures.—Several methods of surface relaxation with or without approximation sutures are useful, and occasionally one of these constitutes the only method of managing a wound which should not be sutured. The simplest of these is the use of adhesive strips applied parallel to the wound edges to furnish anchorage for stitches or lacing. Narrow strips of gauze applied with collodion at a right angle to the wound edge serve the purpose per-

fectly. I routinely employ this procedure after the removal of skin stitches on the second or third day.

Excellent and easily gauged relaxation can be obtained by the use of muslin strips to which hooks have been sewed and which are applied to the skin with Mastisol or any of the good surgical glues. Braided silk is then laced through these hooks, or rubber bands are stretched across them to produce the desired tension (Fig. 22).

A narrow strip of adhesive tape applied beneath the chin, carried around the angles of the mouth, crossed over the nose, and applied to the forehead furnishes ideal relaxation of the lips.

The manner of approximation of the skin edges and the subsequent treatment of the stitches and the healing wound largely determine the quality of the results. Sutures must be *properly passed* and

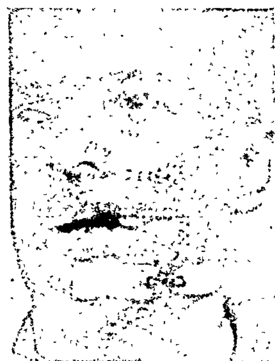
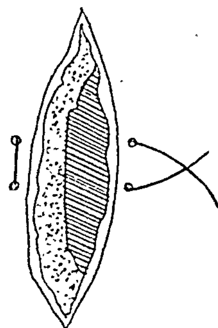


Fig. 22.



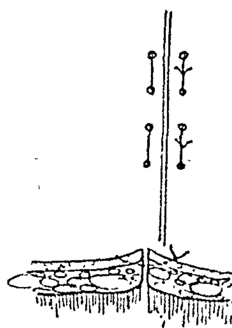


Fig. 23.

Fig. 22.—A method of surface relaxation, by employment of collodion or adhesive strips, used in management of a wound (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

Fig. 23.—Horizontal mattress suture (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

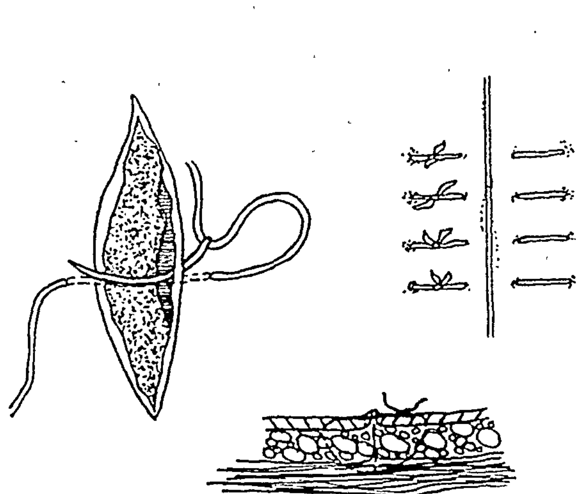
lightly tied if fine results are to be obtained. Numerous useful and efficient methods of closure are available.

Interrupted Sutures or Horizontal Mattress Sutures.—These are preferred about the face. It is good practice to evert edges slightly with mattress sutures and complete the approximation with a simple suture which is either doubly twisted or tied. The use of interrupted sutures permits accurate control of tension and removal of a tight or infected stitch without disturbing the remainder of the repair (Figs. 20, 21, 23).

Vertical Mattress Sutures.—The "on-end" or vertical mattress suture of *McMillen* furnishes both relaxation and approximation. *Blair's* modification of this technic to produce eversion of the wound edges furnishes an ideal suture (Fig. 24). A rapid method of applying this

vertical mattress suture without interruption is described by *C. S. White* (Fig. 25).

Another excellent method is the *subcuticular stitch* described by *Halsted*. The suture is first passed through the whole skin at one



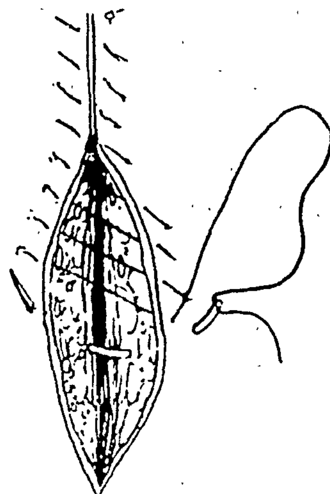


Fig. 24. Fig. 25.

Fig. 24.—Vertical mattress suture (McMillen).
Fig. 25.—Continuous vertical mattress suture (White).

end of the wound and fixed by a knot or a shot. Subsequently, it is passed through the deep layers beneath the epithelium to emerge, finally, on the skin surface at the opposite end of the wound, where it



Fig. 26.—Halsted's subcuticular stitch.

is again either tied or shotted. The most satisfactory results follow the use of a removable suture material (Fig. 26).

Dressing and Care

The immediate dressing and subsequent care of the wound are as important as the operative technic. It is not possible to support a fixed rule for this procedure since the problem varies with the location of the wound and with each case. Some dressings are changed daily to permit inspection and some, at intervals of several days; those on free full-thickness flaps are not opened until the twelfth day.

Oral and Nasal Drainage.—Areas about the mouth and nose demand entirely different management from those about the cheeks, forehead, and neck. Secretions from the oral and nasal cavities fre-

quently contaminate the wound unless precautions against this accident are practiced. Wounds inside and about the mouth and on the nostrils and small repairs about the face are painted with compound tincture of benzoin and exposed to the air. *Stitch lines in the mouth, cheeks, and palate do best when not interfered with in any way.* The mouth is frequently cleansed with an appropriate wash.

Serous drainage during the first twenty-four hours is carefully sponged away from the surface wounds with small cotton swabs soaked in hydrogen peroxide, and the wound is kept scrupulously clean. A stitch line is never rubbed or swabbed, but the secretions and crusts are soaked off and gently separated. The knots of fine sutures must be plainly visible at all times.

I prefer alcohol as a first dressing of closed surface wounds and dress them dry subsequently.

Management of Flaps.—Pedicled flaps are dressed dry either with gauze or with gauze saturated with physiologic solution of sodium chloride during the first forty-eight hours. Dry dressing is employed after the serous drainage has ceased. The dressings are sufficiently voluminous and are fixed by smooth, firm bandaging. The dressing of *free skin flaps* is discussed under the heading of "Skin Grafts" (p. 55). All special dressings will be discussed with the surgical procedure demanding them. *Ischemic flaps* are immediately returned to their origin and are not utilized until an adequate blood supply is assured.

Cyanotic flaps can be managed variously: (1) The flap margins may be trimmed sufficiently to increase the tension or "stretch" when it is sutured. This restricts capillary inflow and usually corrects the condition. (2) Multiple stab wounds or "pie cuts" may be made to permit venous drainage. (3) A pressure dressing may be employed. The efficiency of the dressing and the requirement it must meet can be determined before applying the dressing. The pressure is estimated and depends upon the dresser's experience. (4) *Massage* is *harmful* to the flap unless employed briefly.

Removal of Stitches.—Stitches which are tight and any stitches surrounded by reddened areas or other suggestion of infection should be removed immediately. All surface stitches are removed at the end of the *second* or *third day.* Two or three stitches are removed, and the area is supported by a narrow strip of gauze held in place with collodion across the wound at a right angle to the line of union. This procedure is repeated until all stitches have been removed. These gauze supports are replaced as rapidly as the edges begin to separate and are maintained for two weeks or longer to prevent stretching of the scar.

Complications.—The infective accidents and other wound complications will be treated in accordance with accepted practice and that which has been useful in the surgeon's experience. Flaps and grafts on infected bases are best treated with frequent *saline dressings* and indicated drugs. Strong antiseptic dressings are fatal to recently transplanted free flaps (see "At First Evidence of Local Inflammation," p. 6).

PLANNING TREATMENT OF SCARS

It has already been stated that the perfection of an organized scar depends on many factors. Clean incisions at a right angle to the skin surface, sufficient relaxation, careful approximation with slight eversion of the skin edges, early removal of stitches, and gauze collodion support of the wound, together with intelligent dressing, are the principal factors determining the result. Quality of the skin is also a great factor. There are some types of skin which refuse to yield a fine scar despite scrupulous attention to all of these details.

Depressed Scars

These result from improper suturing of the underlying layers and the skin, from loss of tissue and subsequent contraction, from infec-

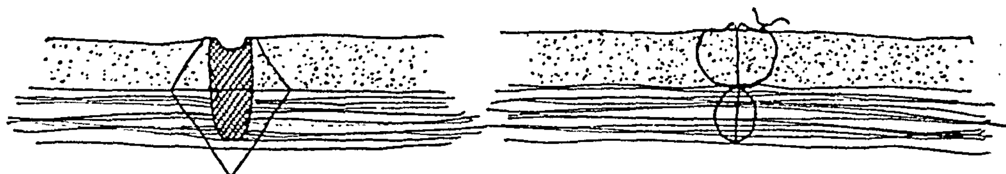


Fig. 27.—Use of oblique incisions for the excision of a depressed scar (Davis). *Left,* approximation of these lines of incision raises the surface level to allow for subsequent contraction; *right,* the wound approximated.

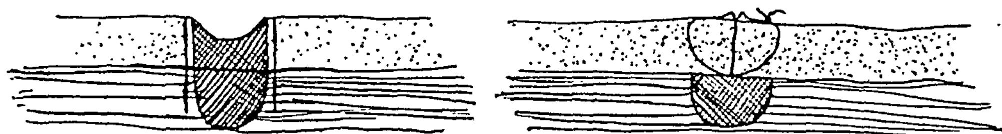


Fig. 28.—A method of employing a deep portion of the scar as a foundation for the skin (Davis). *Left,* the dark lines indicate the incisions and the shaded portions, the scar; *right,* the scar involving the skin has been excised; the skin, undercut and slid to approximate over the deeper portion of the scar.

tion, or from failure of proper union in the deeper layers. Several satisfactory methods of dealing with this type of scar are illustrated in the accompanying diagrams (Figs. 27, 28; see also Figs. 36, 37, 38, 39).

Broad, Smooth Scars

Usually these are slightly depressed, but may be level with the surrounding skin surface. They may be fixed to the underlying tissues but are usually soft and easily movable. *These scars never should be*



Fig. 29.—Method of Aymard (Davis). *Left,* the dotted lines show the usual method of separating the skin. The fat from each side is approximated and the skin sutured over it; *middle,* the blocks of fat outlined by the incision remain attached to, and are approximated with, the skin; *right,* the fat flaps are rolled in and sutured, and the skin is closed over this foundation.

excised and replaced by skin grafts. They are best corrected by multiple partial excision. The smaller ones may be excised, and the borders approximated after free undercutting (Figs. 29, 30, and p. 43).

The method of partial excision suggested by *Morestin* and warmly advocated by Davis gives excellent results. It depends upon repeated

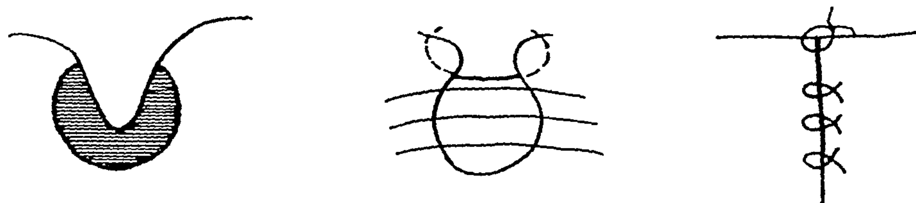


Fig. 30.—Blair's method. *Left,* the lined area indicates tissue excised; *middle,* sutures inserted; *right,* defect closed.

stretching and subsequent relaxation of the surrounding skin, and hence must be accomplished in several stages. An elliptical portion of the scar, as large as will permit suturing of the remaining borders, is excised, and the margins are sutured. This process is repeated at intervals of several weeks, until only a fine linear scar remains.

Contracted Scars

These are the sequels of deep burns, ulcerations and infections, and extensive traumatic tissue losses (Fig. 31).

The repair of this disability frequently presents a most difficult problem and taxes the ingenuity and imagination of the surgeon. *The area of loss resulting in the scar is always considerably greater than the area represented by it.* Nothing can be more astounding to the novice than the defect resulting from the removal of an apparently small, contracted scar of a burn from the neck. The original loss has

been large, and the contraction has depressed and partially fixed the chin by stretching the skin upward from the chest and downward from the margins of the mandible. The line of fixation or anchorage is the narrow area of contracted scar in the center. Its removal leaves



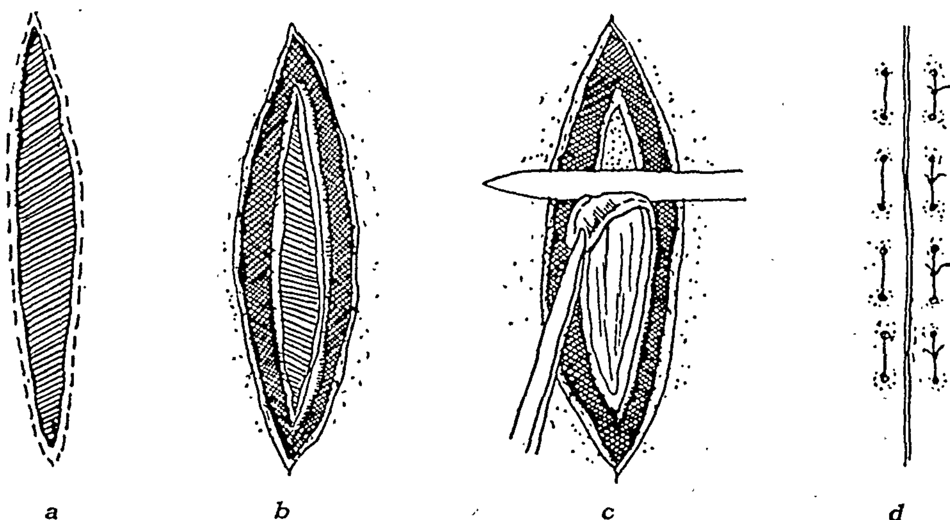


Fig. 31.—*Photograph, contracted* scar. *Sketch,* Poulard's correction of *adherent and depressed* scars. *a,* The lined area indicates the depressed scar, and the dotted line represents the skin incision about the scar; *b,* the skin is freely undercut about the scar mass; *c,* the epithelial surface of the scar is removed; *d,* approximation with mattress sutures everts the skin.

the entire front of the neck bare from the border of the mandible to the clavicle!

The disability can be corrected only by a *Z* plastic operation, full-thickness skin graft, or pedicled flap.

Hypertrophied Scar and Keloid

An empiric distinction is made between hypertrophied scar and keloid. The former may be defined as an excessive production of fibrous tissue within the limits of the wound, while the latter is exactly the same process in the wound, plus a similar invasion of the surrounding skin. This invasion may assume considerable proportions (Fig. 32) as to both linear extent and thickness.

Such scars consist of a hard, fibrous growth in which there are well-developed, small blood vessels and rich, fibroblastic cell growth between the bundles of fibrous tissue. The growth is usually red, smooth, and shiny and is occasionally nodular. It frequently is the site of an itching, stinging, burning sensation. Because of the great



Fig. 32.—Hypertrophied scar and keloid in the same incision.

frequency of its occurrence and recurrence in individuals with extensive burns, and because of its rare appearance in white people without this lesion, one is led to believe that its presence must depend on some permanent chemical changes. Nothing is more embarrassing than its presence in wounds about the neck and face. Hypertrophied scar is usually self-limited in duration and gradually disappears in the course of a few months.

Management of Keloid.—Many treatments have been advanced for the control or removal of keloid. The results are frequently indifferent and disappointing. *Morestin's* method of repeated excisions yields pleasing results in some instances and nothing whatever desirable in others. In fact, the bulk of the mass is increased in some cases. The excisions should be made within the borders of the tumor.

I have had an occasional desirable result from *massage* of the area of the new scar with 5 per cent *pyrogallic acid ointment.* The application is discontinued when evidence of irritation appears and resumed again when it disappears. This process is continued for several weeks. *Roentgen and radium therapy* immediately before and following excision have yielded the best result.

Large areas are treated by excision and grafting, with full-thickness free flaps or pedicled flaps. This procedure is supplemented by radiation to prevent the excessive scar border which forms about the graft.

Z Plastic Operation

This is one of the most useful and satisfactory plastic procedures. It should have *first consideration* in planning the correction of scar contractures and misplaced tissue anywhere on the body surfaces. The end-result relaxes the contraction and changes the lines of "scar pull" to prevent limitation of movement of flexor surfaces. It is often a proper substitution for flap operations. It furnishes an equally good, and often a better, end-result in a much shorter period of time and with less surgical effort.

Indications

1. Scar contractures anywhere.
2. Tissues misplaced and healed "out of line" (lips, eyelids, eyebrows, angles of mouth, and so forth).

Time of Operation.—"Time is the great healer." The changes and improvements occurring during the period of complete organization and relaxation, assisted by local therapy (massage, heat, light, and so on), often remove the necessity for any surgical interference. The blood supply and surface organization are so precarious that the early shifting of tissues often results disastrously. A minimal period of *three months* should elapse between the injury and the repair. The military situation imposes another consideration. If it is essential that the casualty become an effective at the earliest possible time, normal interposed tissue must be employed to correct the disability.

Thick (Deep and Wide) Scar Masses.—If these are unsuitable for the repair because of density and precarious blood supply, they are removed between elliptical incisions. The repair may proceed if the surrounding tissue is sufficiently relaxed to permit adequate shifting of the flaps. Otherwise, the incision is closed and the area allowed to heal.

Lengths and Angles.—The length of the component arms of the Z should be equal. The actual length depends on the area involved and the character of the tissue (Fig. 33).

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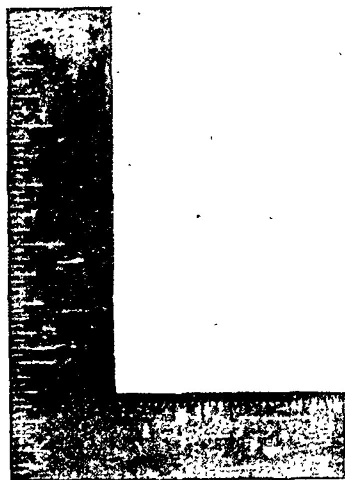
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ence between CD and AB increases with the angle. The greater the angle, the greater the relaxation obtained and vice versa. The difference between the two lines becomes so great above 130 degrees that the included flaps cannot be transposed. If the angle is less than 30 degrees, the length of the central member of the Z (AB, Fig. 33, *upper left*) becomes greater than the line CD (Fig. 33, *upper left*), and the flaps cannot be transposed. The change in the positions of the letters A, A^1, B, B^1, C, and D makes clear the transposition which is effected.

Application

1. Put the scar on tension.
2. Place the central member of a Z (AB in Fig. 33, *upper left*) of proper size along the line of greatest elevation and tension. Puncture the distal points with a hypodermic needle of moderate bore dipped in methylene blue.



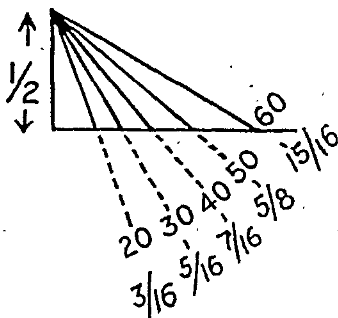


Fig. 34.—*Left,* boilable metal square; *right,* projection scale for determination of angles of flaps.

3. Lay out the arms of the Z (AD and CB) at each end and on opposite sides of the central member (AB) so that they form angles of 60 degrees with the central member (AB). Mark their distal ends with the needle and blue. A metal square (Fig. 34, *left*) and a scale (Fig. 34, *right*) permit accurate planning of the angles and arms.
4. Incise to connect the blue points. *Do not cut sharp angles on flaps.* This produces two triangular flaps ABC and B'A'D.
5. Handle with sharp hooks. Undercut the flaps freely and remove underlying scar.
6. Control all bleeding.

The angles formed by the arms and the central member should be equal for the usual case, but they may be unequal if this is desirable. The angles increase about 15 degrees when cut. Factors which limit the use of flaps to those resulting from angles ranging from 30 degrees to 60 degrees are: (1) thickness of flaps which are viable; (2) location and size of contracture. If the angles are made unequal, the smaller can be made as low as 20 degrees.

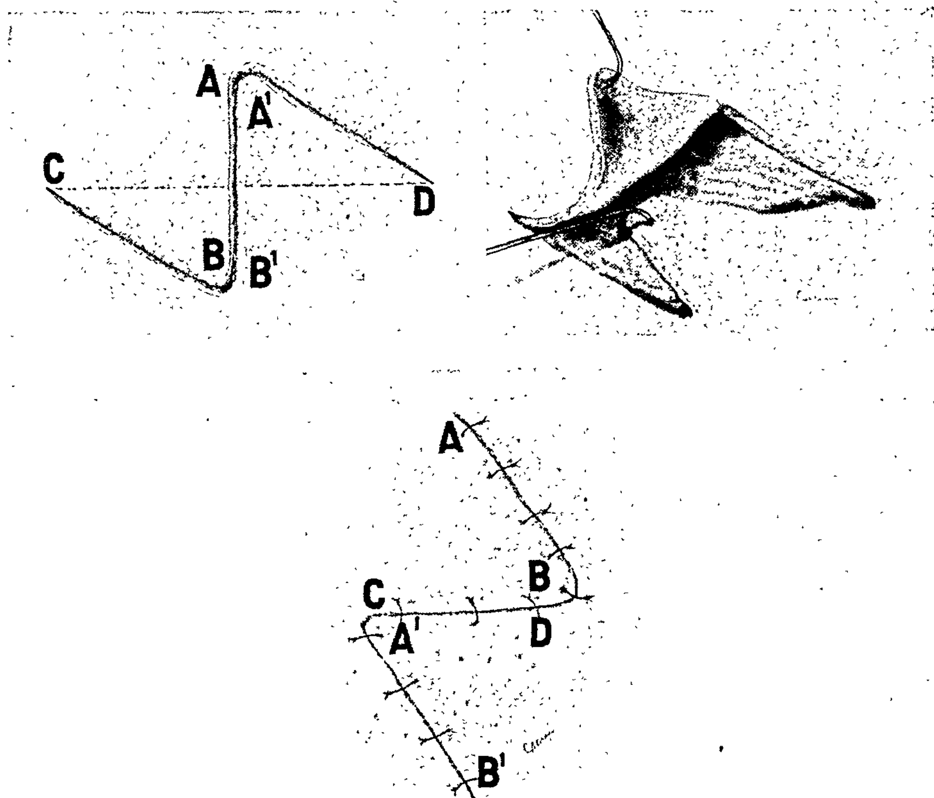


Fig. 33.—*Upper left,* outline of *Z* flaps with a vertical central member; the letters and numbers on the face of the drawing are explained in the text; *upper right,* transposition of dissected flaps; *lower,* approximation of *Z* flaps; the vertical central member becomes horizontal.

The difference between the length of a line CD (Fig. 33, *upper left*) connecting the distal ends of the arms of the *Z* and the length of the center member AB gives the approximate amount of relaxation obtained. CD = 2⅝ inches (6.6 cm.). AB = 1½ inches (3.8 cm.). The difference, 1⅛ inches (2.8 cm.) = relaxation.

The greater the angle formed by the arms and the central member of the Z, the greater the distance CD. The length of the central arm being a constant regardless of the degree of the angle, the differ-

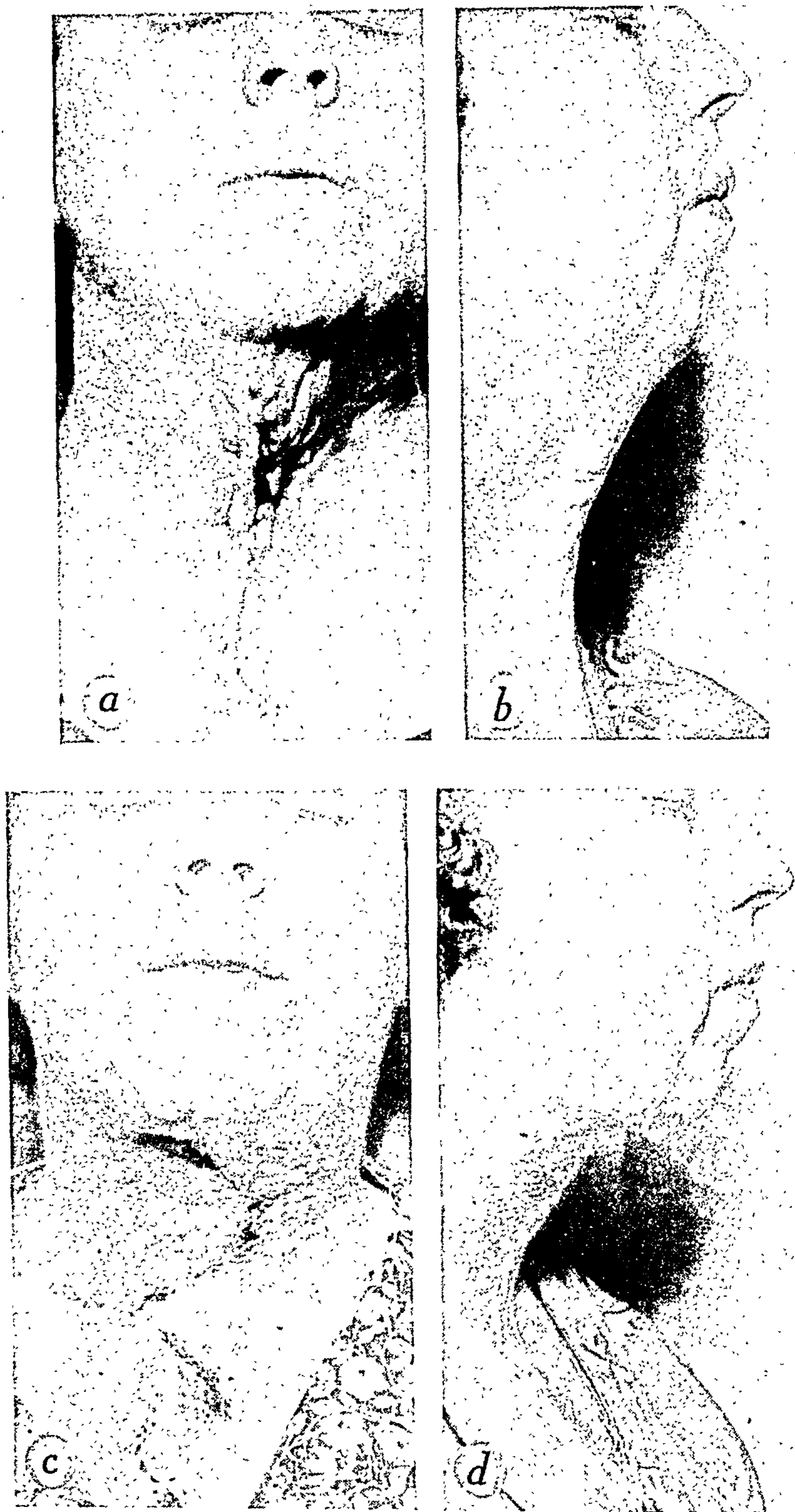


Fig. 36.—*a* and *b*, Scar contracture in the median line of the neck distorting the neck and chinline and partially fixing the head; *c*, *Z* flaps with unequal angles; *d*, result of *Z* plastic procedure.



Fig. 35.—*Left*, scar contracture from the arm to the pectoral region, limiting elevation of the arms; from the angles of the jaw to the base of the neck and from the mental region to the manubrium, limiting movement of the head and distorting the mandible. Note the elongation of the mandible due to long-continued traction. *Middle*, result after a *Z* plastic procedure. Note *Z* scars on the shoulder and upper arm. *Right*, *Z* flaps with unequal angles.

the eyelids, of the ala and the tip of the nose, and of the angles of the mouth. These are of no interest, if they are merely temporary and will be eliminated with the completion of work (Fig. 39).

The final scar should be linear and fine. It should be located, if possible, in a least conspicuous place (before the ear, near the hair-line, below the mandible, and so forth).

The procedure can be utilized for burn scars and keloid, for wide wound scars, for deep powder stains, and so on.

Method

1. The incision is elliptical and is made within the defect, if this is elongated or linear in character. If the defect is circular or irregularly so, the incision is planned about the border on the



Fig. 37.—Multiple excision. *Left,* the dotted lines bound a pinkish red nevus on the face and neck; *right,* result of four excisions; removal of pigmented skin from the borders of a periauricular incision.

side opposite to the area from which the normal skin will be drawn.
2. Undercut the defective and surrounding normal skin to an extent permitting maximal removal of defective tissue. *Do not undercut the opposing normal skin if its stretching produces distortions* of eyelids, nose, or mouth which will not be corrected.
3. Excise the maximal amount of defect permitting closure without undue tension. This may be determined by stretching the normal bordering skin toward the lesion and overlapping it with the dissected defect.
4. Obtain total hemostasis.
5. Effect ordinary approximation.

7. Transpose the flaps so that the edge (line) CB approximates the edge (line) A′D (Fig. 33, *lower*).
8. Stitch without tension.

The sutured wound now presents a Z rotated about 90 degrees from the original and with its center member transverse to the original line of scar pull (Fig. 33, *lower*).

Modification of Z Plastic Operation

An elaboration of the Z plastic operation can be used for long lines of contracture on the fingers, arms, legs, and so forth.

Lay out a long central member and a series of lateral arms of the same angle and short length. These arms alternate on each side of the central arm exactly as in the single Z. Small flaps must be formed on the fingers where little tissue and no elasticity is available. The Z may be performed at intervals on long contractures of the arms and legs (Figs. 35, 36).

Multiple Excision

The principle of multiple, partial excisions was first discussed by Morestin as a gradual reduction of cutaneous deformities. The rationale of the procedure is based on the fact that the skin in early and middle life is elastic and that it rapidly regains normal relaxation and elasticity after being put on marked stretch or tension.

The purpose of removing exposed (facial and cervical) scar and stained areas is both economic and cosmetic, the former being quite real and depending on the latter. The casualty is entitled to the best cosmetic result that can be produced. He must not be handicapped, either mentally or commercially, in his subsequent economic struggle. Such a desirable cosmetic result cannot be obtained with transplanted skin flaps and grafts. Their cosmetic behavior is unpredictable. One of three things happens in about equal proportions: (1) the flap or graft suffers an intensified pigmentation to assume a prune-juice color; (2) the flap or graft has a dirty, grayish white, glazed appearance not unlike a china dish which has weathered; (3) the flap or graft approximates the color of the surrounding skin, but never matches it.

Flaps replacing burned areas and keloid are invariably surrounded by a border of hypertrophied scar, demanding further management. Use of flaps and grafts on the face and neck is frequently a necessity, but their employment should *never* be the procedure of choice. Multiple excision is logical, sensible, and easy of execution.

The *planning* in treatment of large defects must be carefully and correctly considered (Figs. 37, 38). It must contemplate distortions of

Morestin repeated this procedure at intervals of a few days. This is impossible, despite the fact that the surrounding skin relaxes rapidly, if the dissection has been free and the removal maximal. Three months





Fig. 39.—Multiple excision. *a* and *b*, Result of roentgen therapy of a black nevus of the face and neck; persisting nevus, marked atrophy of skin, and early sarcoma; *c*, result after excision of sarcoma and three multiple excisions of involved skin; *d*, result of two additional excisions and the transposition of a triangular flap of infra-orbital scar and a similar flap of normal skin from the border. This permitted advancement of the interpolated skin to replace the entire infra-orbital scar without producing ectropion; *e*, photograph taken fifteen days following final operation.

is the earliest that relaxation, adequate to justify the next procedure, occurs. This results from daily manipulation and massage.

FOREIGN BODIES: REMOVAL

Remember the old adage: "When a bullet ceases to move, it ceases to do damage." This is not literally true when one considers the various types of missiles which may become embedded in the body (bullets;





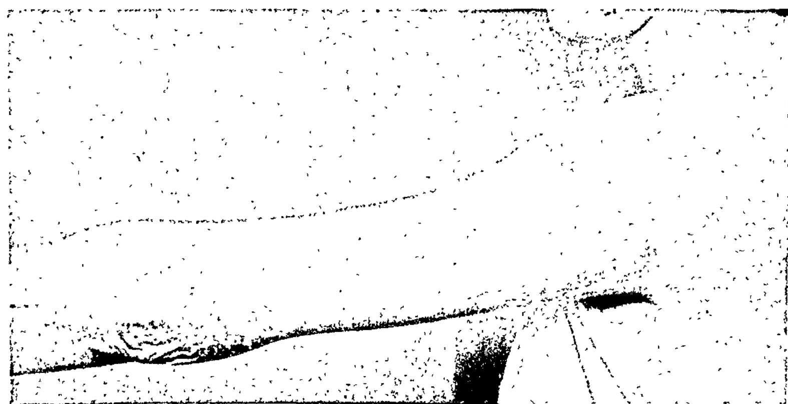


Fig. 38.—Multiple excision. *Top,* pigmented, hairy mole covering the entire upper arm and shoulder; *center,* tubed pedicle flap from the axilla transplanted to the elbow and forearm; *bottom,* result (six years later) of transplantation of the skin in the tubed pedicle and subsequent multiple excisions. This transplanted skin ultimately covered the entire circumference of the arm.

jagged metal strips; splinters of metal, wood, or glass, and so forth) and their final locations.

Those which abrade or penetrate the walls of vessels (Fig. 40) and nerves, or the *spinal column,* to injure the spinal cord, create an emergency which must be dealt with immediately. Those which have created and are maintaining suppuration must be removed as soon as the condition of the casualty permits. Those which fulfil the statement of the axiom may be removed at the discretion of the surgeon.

Remember a second adage: "A wound on the surface caused by the entrance of a bullet does not mean, necessarily, that the bullet has remained in that vicinity." The location and removal of the roentgenologically demonstrable foreign body frequently requires the greatest cooperation and skill of the surgeon and the roentgenologist.

Localization

The roentgenologic methods employed for localization are: (1) the two-wire, double-shift method of Strohl; (2) triangulation, single-tube shift; (3) use of the localizing profundoscope (Reed-Black); (4) intermittent roentgenoscopy, using the bonnet roentgenoscope.

These methods enable the roentgenologist to measure accurately the distance from several surface points to the embedded foreign body. It would seem relatively simple for the surgeon to follow the roentgenologist's directions to the foreign body. Vitally important structures frequently intervene, necessitating an approach and procedure much more taxing to both collaborators than a direct one. The roentgenologist frequently must direct the actual course of the surgeon to the foreign body, despite its accurate mathematical localization. This requires of both more than the ordinary familiarity with orthodox topographical and sectional anatomy. It demands sound judgment to accomplish removal without added disability to the patient.

The skull is composed of so many bones which may be used as landmarks that the utilization of some of these methods of study readily accomplishes a satisfactory localization. The neck presents greater difficulty, but the application of these methods permits localization and removal without great hazard to the patient.

An excellent discussion of this subject in an article from the Department of Roentgenology of the Army Medical School should be studied carefully (Reed, E. K., and Black, L. F.: Foreign Body Localization in Military Roentgenology. Radiology. *31:* 567–583 [Nov.], 1938).



Fig. 40.—Lead bullet of large caliber in the median border of the foramen lacerum. The bullet was wedged against the internal carotid artery. It was removed through the tract in the maxilla under local anesthesia ten days after it had been received. *Upper,* anteroposterior view; *lower,* lateral view.

sternocleidomastoid muscle and open the connective tissue. The upper border of the omohyoid muscle is here exposed, either by direct incision or by following up the anterior border of the sternocleidomastoid. The sternocleidomastoid muscle is retracted downward and the omohyoid muscle downward at the point where it passes beneath the sternocleidomastoid. The common carotid artery is located as it passes the "carotid tubercle." Avoid or tie the sternomastoid artery and superior end of the middle thyroid veins. Incise the sheath carefully from the inner side to avoid the descendens hypoglossi nerve and the internal jugular vein. Free the artery from its sheath in its entire circumference. Pass the ligature from the internal jugular vein and vagus nerve.

Collateral Circulation.—Inferior thyroid with superior thyroid. Deep cervical with occipital. Transverse cervical with occipital. Branches of two vertebrals with branches of two external carotids. Circle of Willis.

Ligation of External Carotid Artery below Digastric Muscle

Landmarks.—Sternocleidomastoid muscle; thyroid cartilage; angle of jaw.

Incision.—Incision from the level of the middle of the thyroid cartilage for a distance of 3 inches (about 7.5 cm.) to a point near the angle of the jaw along the anterior border of the sternomastoid muscle (Fig. 42).

Procedure.—Incise skin, superficial fascia, and platysma muscle. Divide and tie any veins in the line of incision. Divide the deep fascia and expose the anterior border of the sternocleidomastoid muscle. Retract it outward. Find the posterior belly of the digastric muscle at the upper angle of the wound. Locate the hypoglossal nerve crossing the external carotid artery below the origin of the occipital artery. Locate the tip of the great cornu of the hyoid bone, opposite which the lingual artery arises. Expose the artery opposite the tip of the great cornu of the hyoid bone—avoid the superior thyroid, facial, and lingual veins. Clear the sheath and pass the ligature between the superior thyroid and lingual branches of the external carotid artery, guarding the descendens hypoglossi nerve in front and the superior laryngeal nerve passing behind the artery; direct the needle from the internal carotid artery. The superior thyroid, lingual, external maxillary (facial), occipital, and ascending pharyngeal arteries may be ligated through this same incision.

Collateral Circulation.—Same as for ligation of the common carotid artery above the omohyoid muscle.

LIGATIONS

Ligation of Common Carotid Artery above Omohyoid Muscle

Landmarks.—Line of artery; anterior border of sternomastoid muscle; cricoid cartilage.

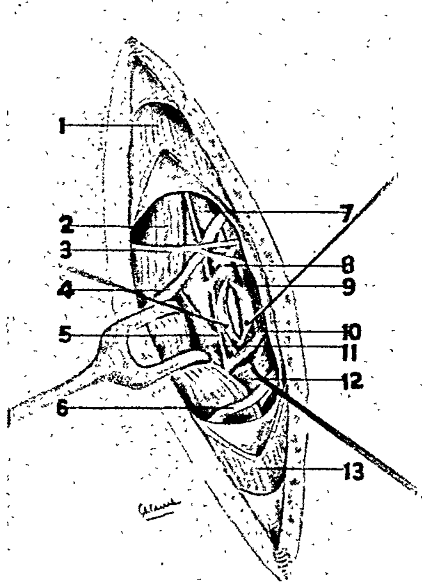


Fig. 41.

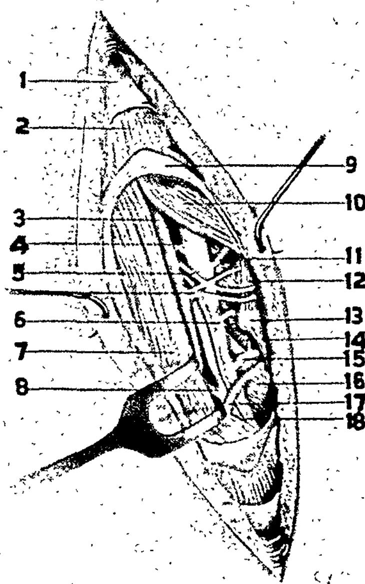


Fig. 42.

Fig. 41.—Dissection for common carotid artery (Bickham). *1,* Platysma muscle; *2,* sternocleidomastoid muscle; *3,* one of transverse cervical nerves; *4,* sternomastoid artery; *5,* nerves from loop between descendens hypoglossi and descending cervical; *6,* communicating vein between anterior and external jugular; *7,* common carotid artery (sheath incised above omohyoid muscle); *8,* superior thyroid vein; *9,* sternothyroid muscle; *10,* inferior thyroid vein; *11,* internal jugular vein; *12,* omohyoid muscle (retracted downward); *13,* platysma muscle.

Fig. 42.—Dissection for external carotid artery (Bickham). *1,* Superficial fascia; *2,* platysma muscle; *3,* internal jugular vein; *4,* occipital artery; *5,* hypoglossal nerve; *6,* external carotid artery; *7,* sternocleidomastoid muscle; *8,* internal carotid artery; *9,* cervical fascia; *10,* posterior belly of digastric muscle; *11,* external maxillary (facial) artery; *12,* hyoglossus muscle with lingual artery disappearing beneath it; *13;* tip of great cornu of hyoid bone; *14,* middle constrictor muscle; *15,* superior thyroid artery; *16,* inferior constrictor muscles; *17,* superior thyroid vein; *18,* descendens hypoglossi nerve.

Incision.—An incision 3 inches (about 7.5 cm.) long lying in the line of the artery, with its center at the level of the cricoid cartilage.

Procedure.—Incise skin, superficial fascia, and platysma muscle (Fig. 41). Divide the deep fascia along the anterior border of the

of the digastric muscle and retract them downward at their point of attachment to the hyoid bone. This renders the hyoglossus muscle more prominent. Identify the hypoglossal nerve crossing its anterior aspect. The ranine vein (vena comitans of hypoglossal nerve) crosses just below and parallel to the nerve at about the level of the artery on the opposite side of the muscle. Retract the hypoglossal nerve and ranine vein upward. Divide the hyoglossus muscle transversely for ½ inch (about 1.3 cm.) just above and parallel with the hyoid bone. This incision is immediately over the artery, which generally bulges into the opening or is easily reached. Trace the artery backward until the dorsales linguae branches are reached so that the ligature may be placed on their proximal side.

Ligation of Facial Artery over Inferior Maxilla

Landmarks.—Anterior margin of masseter muscle and the horizontal portion of the inferior maxilla.

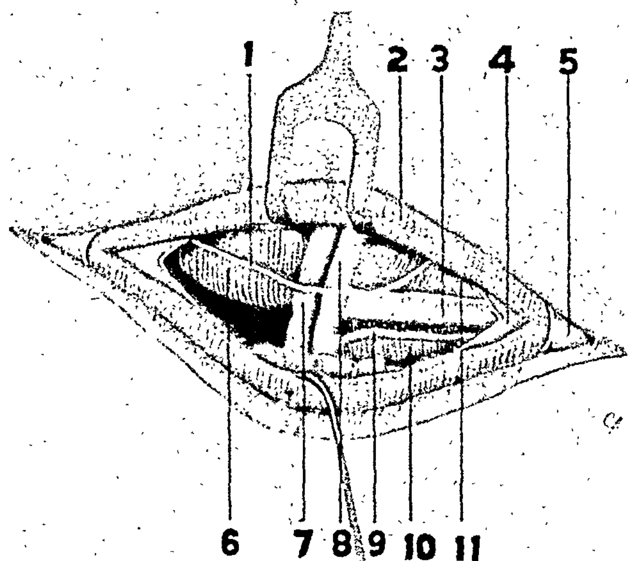


Fig. 44.—Dissection for facial artery (Bickham). *1,* Supramaxillary nerve; *2,* platysma muscle; *3,* inferior maxilla; *4,* deep cervical fascia; *5,* superficial fascia; *6,* masseter muscle; *7,* facial vein; *8,* facial artery; *9,* submental artery; *10,* mylohyoid muscle; *11,* depressor anguli oris muscle.

Incision.—About 1 inch (about 2.5 cm.) in length, placed parallel with and under the lower border of the jaw, with its center at the anterior margin of the masseter muscle.

Procedure.—Incise the skin, superficial fascia, platysma, and deep fascia, exposing the artery (Fig. 44). The facial vein lies posterior to it. Avoid branches of the facial nerve.

Ligation of Lingual Branch of External Carotid Artery, beneath Hyoglossus Muscle

Landmarks.—Lower border of inferior maxilla; facial artery crossing inferior maxilla; hyoid bone.

Incision.—A curved incision beginning just below and external to symphysis menti and ending just below and internal to the crossing

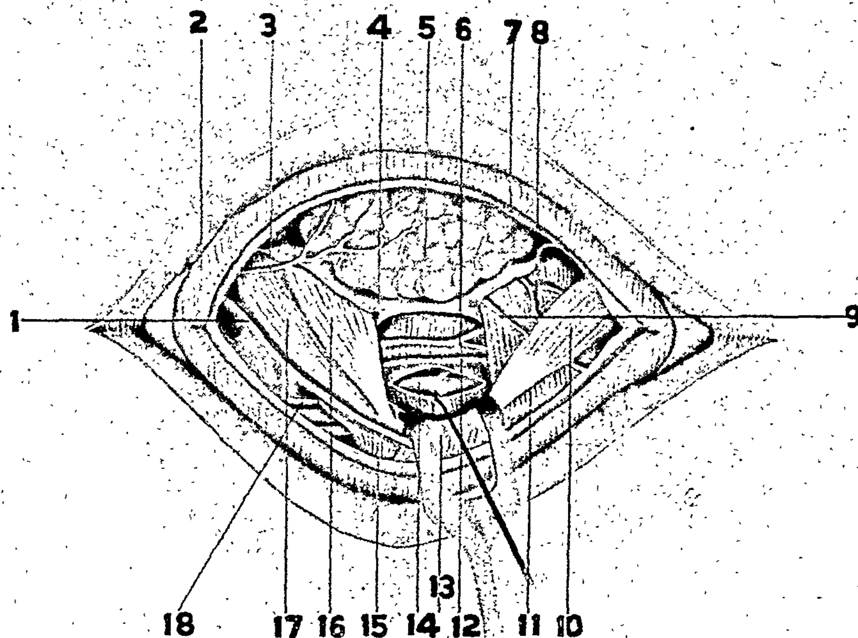


Fig. 43.—Dissection for lingual branch of external carotid artery (Bickham). *1,* Transverse cervical nerve; *2,* platysma muscle; *3,* tributary of temporomaxillary vein; *4,* deep cervical fascia under submaxillary gland; *5,* submaxillary gland; *6,* hypoglossal nerve; *7,* deep fascia; *8,* submental artery; *9,* tributary of anterior jugular vein; *10,* anterior belly of digastric muscle; *11,* mylohyoid muscle; *12,* ranine vein (vena comitans of hypoglossal nerve); *13,* omohyoid muscle; *14,* lingual artery seen through incision in hyoglossus muscle; *15,* thyrohyoid muscle; *16,* stylohyoid muscle; *17,* posterior belly of digastric muscle; *18,* superior laryngeal nerve and vessels.

of the facial artery over the inferior maxilla. The center of the incision is just above the great cornu of the hyoid bone.

Procedure.—Incise skin, platysma muscle, and deep fascia (Fig. 43). Avoid or ligate tributaries of the facial, anterior jugular, or temporomaxillary veins. Incise the transverse cervical fascia over the submaxillary gland. Retract the gland upward over the margin of the lower jaw. Incise transversely the deep cervical fascia, which is exposed by lifting out the submaxillary gland; identify the mylohyoid muscle in the anterior portion of the wound. Expose the two bellies

Ligation of Temporal Artery, above Zygoma

Landmarks.—The zygoma; tragus of ear; condyle of jaw.

Incision.—About 1½ inches (nearly 4 cm.) in length, in the line of the artery, with its center over the zygoma.

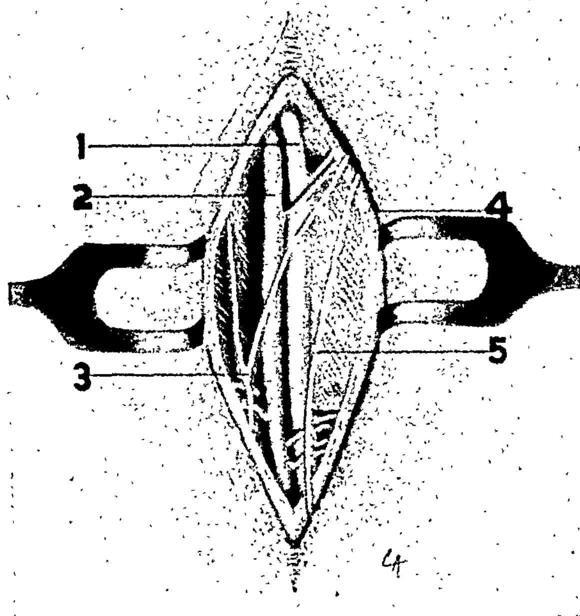


Fig. 46.—Dissection for the temporal artery (Bickham). *1,* Temporal artery with its anterior and posterior bifurcations and its middle temporal, transverse facial, and anterior auricular branches; *2,* temporal vein; *3,* temporal branches of the auriculotemporal nerve; *4,* temporal fascia; *5,* branch of the temporofacial division of the facial nerve.

Procedure.—Incise the skin and parotid fascia, exposing the artery as it crosses the zygoma (Fig. 46). Avoid the branches of the facial and auriculotemporal nerves and the accompanying vein; the last lies posteriorly.

Ligation of Occipital Branch of External Carotid Artery, behind Mastoid Process

Landmarks.—Mastoid process and external occipital protuberance.

Incision.—Begin at the tip of the mastoid process and extend toward the external occipital protuberance for a distance of about 2 inches (about 5 cm.)

Procedure.—Incise the skin and the fascia (Fig. 45). Divide the posterior half of the sternocleidomastoid muscle and its aponeurosis, the splenius capitis muscle, and as much of the longissimus capitis

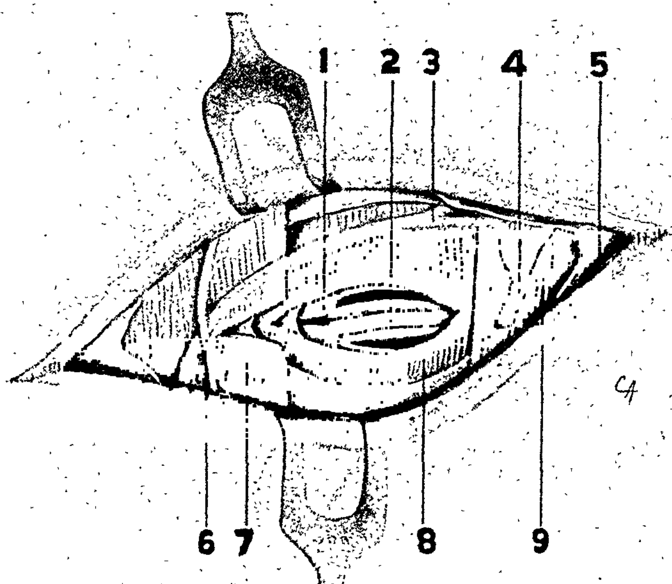


Fig. 45.—Dissection for occipital branch of external carotid artery (Bickham). *1,* Longissimus capitis (trachelomastoid) muscle; *2,* occipital artery and veins; *3,* posterior external jugular vein; *4,* greater occipital nerve; *5,* posterior cervical fascia; *6,* lesser occipital nerve; *7,* sternocleidomastoid muscle; *8,* splenius capitis muscle; *9,* trapezius muscle.

(trachelomastoid) muscle as is in the field. Relax the muscles by turning the head to the side of the operation and retract. The artery will be exposed deep down between the mastoid process and the transverse process of the atlas, resting on the obliquus capitis superior (superior oblique) and semispinalis capitis (complexus) muscles. Separate it carefully from accompanying veins and ligate. The lesser occipital nerve runs on the posterior surface of the sternocleidomastoid muscle, near its posterior border, and the great occipital nerve pierces the trapezius muscle near its outer border.

Ligation of Temporal Artery, above Zygoma

Landmarks.—The zygoma; tragus of ear; condyle of jaw.

Incision.—About 1½ inches (nearly 4 cm.) in length, in the line of the artery, with its center over the zygoma.

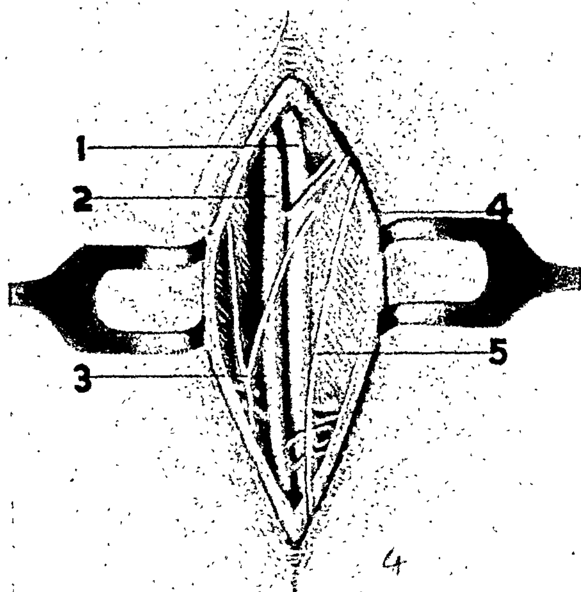


Fig. 46.—Dissection for the temporal artery (Bickham). *1,* Temporal artery with its anterior and posterior bifurcations and its middle temporal, transverse facial, and anterior auricular branches; *2,* temporal vein; *3,* temporal branches of the auriculotemporal nerve; *4,* temporal fascia; *5,* branch of the temporofacial division of the facial nerve.

Procedure.—Incise the skin and parotid fascia, exposing the artery as it crosses the zygoma (Fig. 46). Avoid the branches of the facial and auriculotemporal nerves and the accompanying vein; the last lies posteriorly.

CHAPTER II

CONDENSED DISCUSSIONS

FREE TRANSPLANTATION OF SKIN AND MUCOUS MEMBRANE: GRAFTING

DO *not use isografts* (*another person*) or *zoografts* (*another species*).

Do not transplant on to a bed of questionable sterility.

Any of the various types of grafts will grow on all sorts of fresh wound surfaces and on healthy granulating bases. The wound surface may be any of the constituent soft parts, such as muscle, fascia, perichondrium, periosteum, and so on. The thinner the graft, the more certainly it will grow on areas of poor nourishment.

All grafts live as parasites by absorption of lymph until a new circulation of blood is organized.

Thin grafts of epithelium (Thiersch) will grow on bone and in the presence of infection.

The granulating surface to be covered must have a *zero bacterial count*. It must be firm and have a healthy, reddish pink color.

Preparation of Bed

Numerous methods of preparing the bed are proposed. Wet dressings of saline solution or boric acid solution are useful. Infection, which does not yield readily to this simple treatment, may be eradicated by the use of a dressing of *bacteriophage, peptone,* or *chlorophyl.* Compresses of *potassium permanganate,* 1:1000 changed frequently, or *Dakin's solution* may be required. *Sulfathiazole* dusted on the granular surface usually will sterilize it promptly or inhibit bacterial growth during the time required for growth of the graft.

Davis' Method.—This method of preparation immediately prior to grafting is very satisfactory. The granulations are thoroughly cauterized with pure carbolic acid, removed down to a firm base, and the surface is dressed with gauze impregnated with sterile boric acid ointment. Bandage is firmly applied. The new granulations are ready for the transplant in twenty-four to forty-eight hours.

Types of Grafts

Thiersch Graft.—This includes all layers of the epithelium and the tops of the papillae in the corium. Growth of these grafts is practically certain if they are properly cut, applied, and dressed. They will grow on bone, cartilage, tendon, in the mouth in the presence of secretion, as well as on granulation or a fresh tissue base.

They should be applied on a dry surface. They may be fixed in place by a dressing for a short period; by a mechanical device (mouth); by spreading the graft over a mold and suturing the mold in a prepared pocket (Esser inlay); or they may be applied to the raw surface, protected by a frame covered with gauze, and left exposed to the air (eyelid). Dressings on granulating surfaces should be opened on the second or third day for removal of secretions. The graft may then be dressed dry or exposed to the air.

The *usefulness* of such grafts about the neck and face is very limited. They are used to produce or increase the depth of a buccal sulcus or to line a prepared cavity for a prosthetic eye. This graft will not control the *scar contraction* of granulating or organizing surfaces. It frequently acquires a pearly gray surface or becomes darkly pigmented and contracts (Fig. 47). The epithelium of these grafts, in the mouth, undergoes metaplastic change to suit it to its new environment.

Moszkowicz-Esser-Waldron Epithelial Inlays.—A pocket, somewhat larger than the final area desired, is made by dissection. An impression of this cavity is made with sterile dental modeling compound. This model is covered with split skin, raw surface outward, and inserted into the prepared pocket, after which the edges of the pocket are sutured together.

Ten or twelve days later the wound is opened and the mold removed. The cavity is dried in the air or with the heat from an electric-light bulb, and the mold is reinserted without suture. This procedure is repeated for several days until the new skin is thoroughly organized.

These grafts, for producing or increasing the depth of the buccal sulcus, may be held in place by a mold on a frame, which is attached to bands or splints fitted about the teeth (see Sections II and III).

"Split" Skin ("Intermediate") Graft.—These grafts include all of the epithelium and upper layers of the corium. They do not include sufficient elastic fibers to cause contraction. They are cut ordinarily from 0.016 to 0.020 inch (0.04064 to 0.0508 cm.) thick (Figs. 51 and 52). This added "body" gives a much wider range of usefulness than the Thiersch graft and satisfies all requirements except the pre-

vention of contraction in deep granulating and scar beds. These grafts are indicated for repair of subtotal losses of skin of the face and neck (burns), for replacement of skin on all other parts of the body except areas in which tendons are exposed and for small surface repairs about the nose, ears, and so on.

These grafts are cut in sheets of desired size to overlap the margins of the defect and are fixed in place with a running suture through the graft and the underlying marginal skin of the defect. Larger grafts are further fixed, with one or more such sutures passed through the skin and the bed of the defect. These are placed at intervals of an inch, running the length of the graft. Several "pie cuts" are made for serous drainage.

AUTHOR'S TECHNIC.—The graft is covered with a layer of gauze permeated with scarlet red ointment (5 per cent) and a thin layer of gauze, a moist synthetic sponge (duPont), another layer of gauze sponges, and a moderately firm bandage. This dressing is undisturbed for five or six days, if there are no indications for removing it. The layer of scarlet red gauze is not disturbed if the graft is dry and in proper condition. A fresh dressing of gauze is applied over it.

The stitches are removed on the eighth or tenth day, and the graft is dried in air and re-covered with a light dressing. It is left exposed to the air on the fifteenth day and coated with oil such as is used in the nursery. If drainage occurs, the graft is immediately dressed with gauze sponges wet with saline solution. Such a dressing for the initial two or three days is preferred by some surgeons.

Reverdin (Pinch) Grafts (Figs. 48, 49).—These grafts have *no place in the surgery of the face and neck.* In fact, they no longer have any proper place in modern surgery. They have served to assist in covering raw surfaces, but they can neither prevent scar contraction nor produce an acceptable cosmetic result. The "split" graft is more readily obtained, more easily applied and dressed, and it produces a far superior result.

Wolfe (Full-Thickness) Grafts (Figs. 48, 96, 129, 143, 155).—These are the *grafts of choice* in most instances for replacing *full-thickness skin losses* of the face and neck, for replacing skin loss of the eyelids (ectropion and so forth) or of the nose, and so on. Grafting is not the procedure of choice for these losses but frequently one of necessity.

They are grown with great certainty when all of the required conditions are complied with. It is obvious that this graft is a parasite existing on absorption of lymph during the first two or three days. Hence, its intercellular spaces must be open to the absorption of

lymph in order that nourishment may reach its cellular elements. Whole blood cannot accomplish this requirement, and collection of blood beneath a graft causes it to perish.

The graft must be cut accurately to the *size of the defect* which is to be filled. For the same reason, the graft must be *accurately approximated* by carefully placed sutures. The entrance of lymph from its circumference and the early ingrowth of vessels around this border are big factors in successful nourishment. The graft must be *free from fat,* for obvious reasons. The graft must be *accurately approximated to its base by a proper, even pressure.* The "proper" pressure—the one which produces the maximal supply of lymph in the area—is approximately 30 mm. of mercury. This may be accurately gauged by in-

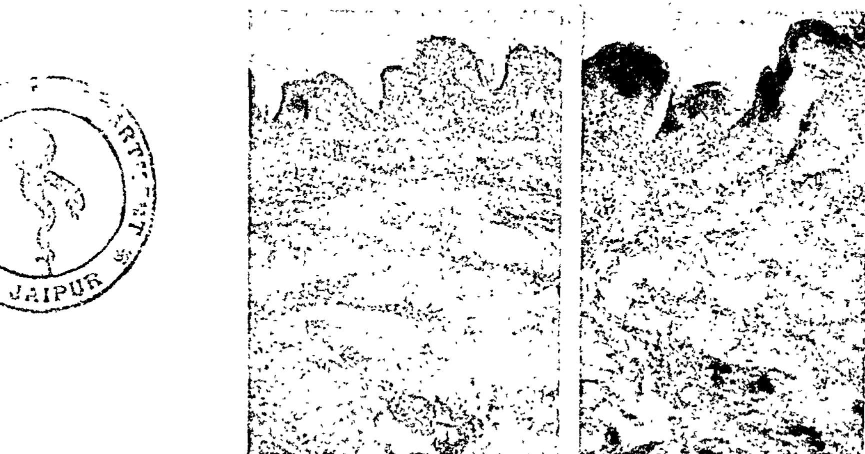


Fig. 47.—*Left,* skin under normal tension; *right,* contracted skin. Note that the subepithelial tissues lie in somewhat parallel bundles in the skin under normal tension and that the basement membrane is practically horizontal. Compare with the contracted skin (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

corporating a specially designed, flat, rubber bag or the arm cuff of a blood-pressure manometer in a rigid dressing (plaster) and inflating to this point on the scale of the pressure machine. The tube to the bag is clamped and not disturbed until the dressing is removed (twelve days). The surgeon with experience can gauge the bandage pressure with a fair degree of accuracy, but his percentage of success is less than that when the controlled method is used. Finally, the part should be *immobilized for twelve days.*

The graft has a well-established blood supply at this time (twelve days)—not sooner as a rule. Motion will destroy the lymph adhesion of the graft to the bed and disturb the formation of new circulation at the borders and the base.

The walls of the young vessels collapse when pressure is removed sooner. A flap which appears splendid when the dressing is removed on the tenth day frequently becomes cyanosed and dies. The graft

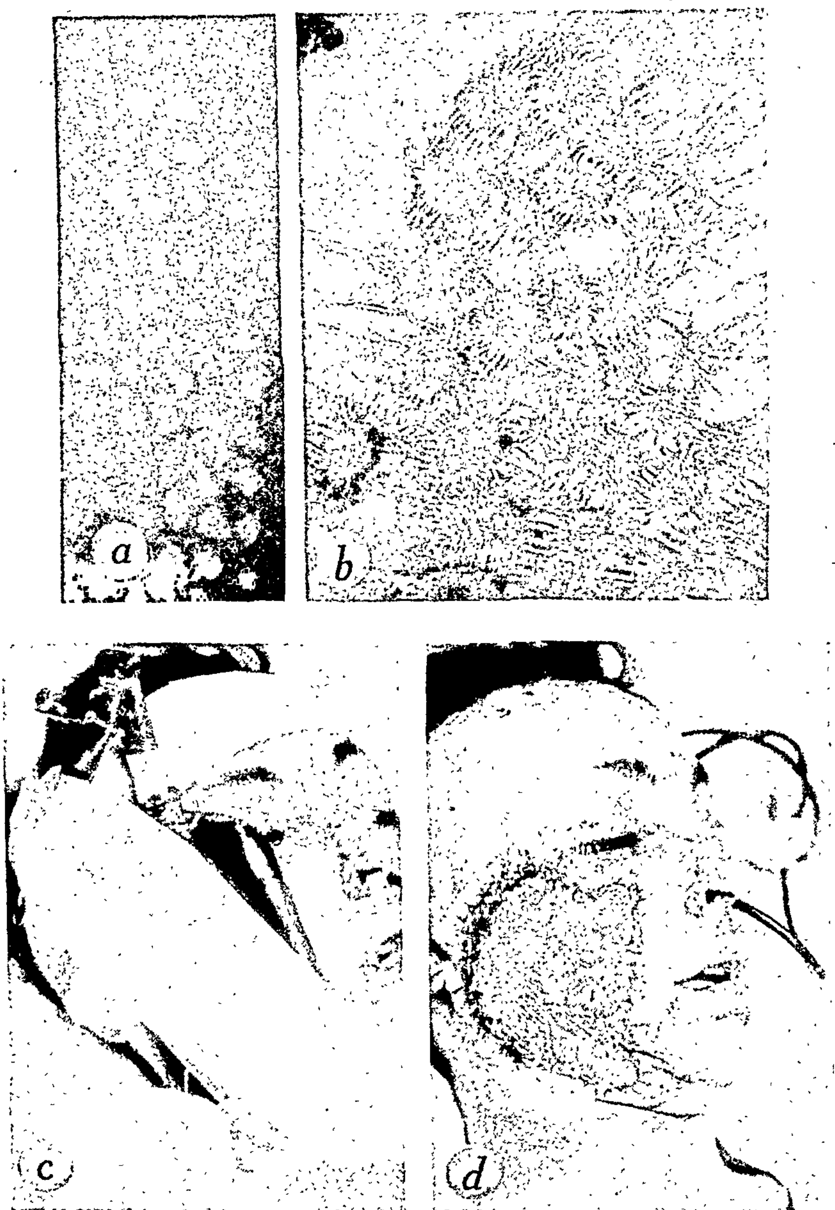


Fig. 48.—Reverdin or "pinch" grafts, Wolfe graft. *a*, Area of removal of pinch grafts; *b*, appearance of grafts after organization; *c*, pressure-bag dressing on a Wolfe or full-thickness graft; *d*, appearance of the graft immediately on removal of the pressure dressing (twelve days).

presents a pinkish white color when its condition is ideal. Occasionally, areas are found in which the surface epithelium is separating from a corium which is in a healthy, growing condition. This area is kept dry until it separates. The epithelial layers usually regenerate.

The graft is redressed with moderate pressure for several days before exposure to the air. It is then oiled until its epithelial surface is

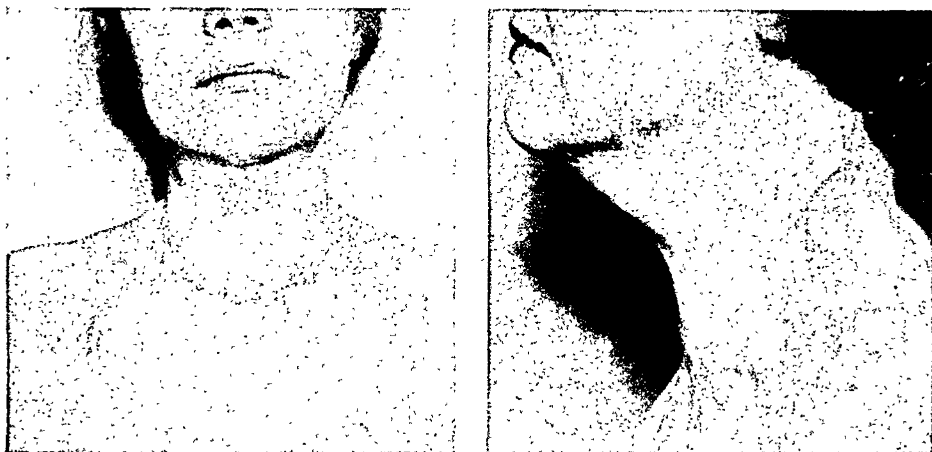


Fig. 49.—Patient presenting Reverdin (pinch) grafts on the shoulders; Wolfe (full-thickness) graft on the chest and at the base of the neck; a pedicled flap graft covering the neck. This replaced a large number of contracted pinch grafts.

well organized. The various types of wet dressings, metal foils, powders, and so forth, are in no wise essential to the growth of grafts.

Cutting of Grafts

Split grafts are cut "free hand" with any sharp knife or razor of proper length. Special razors with either fixed or removable blades

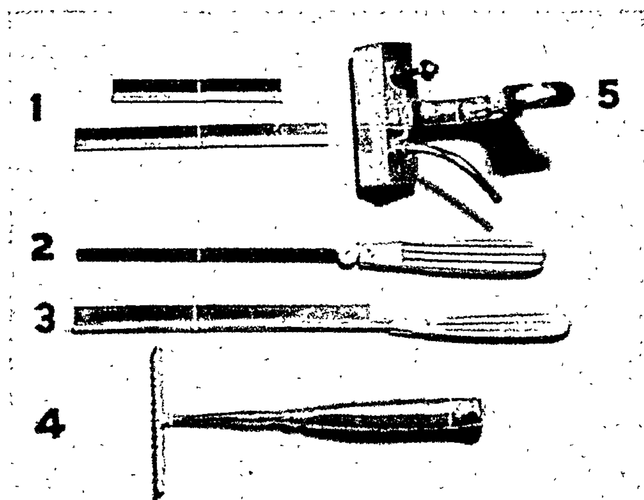


Fig. 50.—Razors and traction instruments for the cutting of grafts. *1* and 2, Removable blades of different lengths and handle (Ferris Smith); *3*, razor with a fixed blade (Blair); *4*, sharp-toothed stretcher (Ferris Smith); *5*, vacuum tractor for producing skin tension (Blair).

of varying lengths are available. Those with removable blades are more likely to be sharp when needed (Fig. 50).

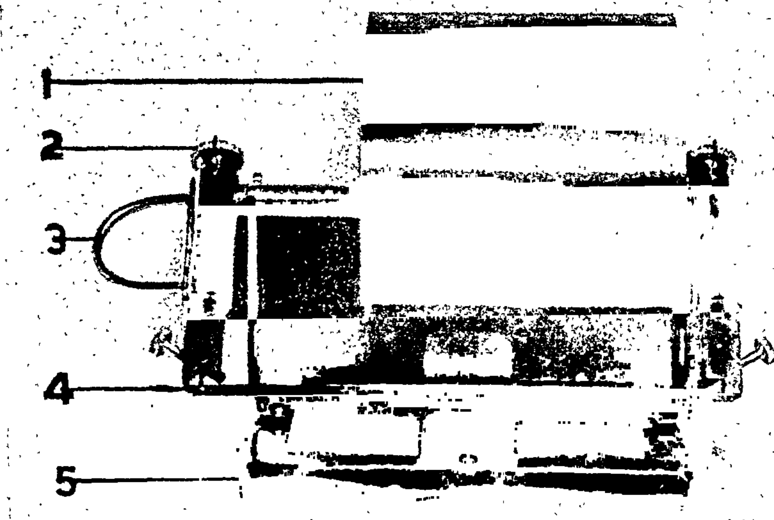


Fig. 51.—Padgett's dermatome. *1,* Drum; *2,* knurled knob operating a micrometer adjusting screw; *3,* handle for moving the knife to and fro longitudinally; *4,* knife-blade holder and knife; *5,* stand.



Fig. 52.—Area on the back resulting from the removal of a single graft. *Inset,* the graft on the drum at the completion of cutting.

The skin is smeared with a thin film of sterile vaseline, held flat and tense with two sterile boards, the straight edge of a rectangular basin, with stretcher hooks designed for the purpose or with vacuum cups (Blair). The razor is engaged and moved with a to-and-fro

sawing motion until the desired graft is completely cut. The graft should be transferred to its bed immediately.



Fig. 53.—*a* and *b*, Basal cell carcinoma of the face; *c*, defect after destruction of the carcinoma; *d*, six years later; the appearance of a single split skin graft covering the defective area; the paralyzed eyelids support each other by a surgical adhesion between them at the outer and middle thirds.

Grafts are cut mechanically with the *Padgett dermatome.* This device permits one to cut a sheet of skin of any size up to 4 by 7¾ inches (about 10 by 19 cm.) and of uniform thickness. The skin may be removed from any part of the body, some parts of which are not suitable for use of razor (inside of thigh, middle of the back, and so

forth). The calibration of the knife supports permits cutting grafts of any desired thickness available in a particular skin (Figs. 51, 52, 53). This device will not be available always. The surgeon must be prepared to obtain skin in the ordinary manner (razor).

The raw surfaces created by the removal of "split" or shaved skin are dressed with boric acid ointment gauze. They are untouched until healing is complete.

Full-thickness grafts are removed from the arm or the inside of the thigh to cover hairless areas and from any part of the body for other use. They are usually removed from the abdomen because closure of the defect is easy. The graft is outlined, dissected free from fat, and immediately transferred to the prepared bed. The defect is closed by undermining its borders or by transfer of suitable flaps.

Mucous-membrane grafts are obtained from the lower lip, the buccal mucosa, the covering of a section of middle turbinate bone, or from the conjunctiva. They are managed in the same manner as skin.

FRACTURES OF FACE: BONE LOSS

The *frequency* of fractures of the facial bones (Fig. 54) is in the following order: mandible, nose, zygomatic compound (bone and arch), maxilla, and multiple fractures.



Fig. 54.—Bony anatomy of the face, nose, and zygomatic arch. *1,* Frontozygomatic articulation; *2,* orbital articulation of the zygoma and maxilla; *3,* zygomatic process of the maxilla, maxillary zygomatic articulation; *4,* articulation of the zygoma and zygomatic process of the temporal bone; *5,* infra-orbital foramen.

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short (perpendicular) side (Fig. 55; see also Fig. 59). The nasal bones (en masse) are somewhat rotated and carried in the direction of the force either to lock under or to override the fractured edge of the nasal (frontal) process of the distal fragment.

The nasal septum (perpendicular ethmoid plate) is carried laterally with the nasal bones to constrict the upper half of the airway. It frequently suffers multiple fractures and is separated from the vomer. The cartilaginous (quadrilateral cartilage) portion is bent or fractured (greenstick) with the nasal bones and becomes dislocated from its groove in the vomer. This produces the S-shaped nasal ridge, so typical of this type of fracture, and distortion of the columella and nostrils.

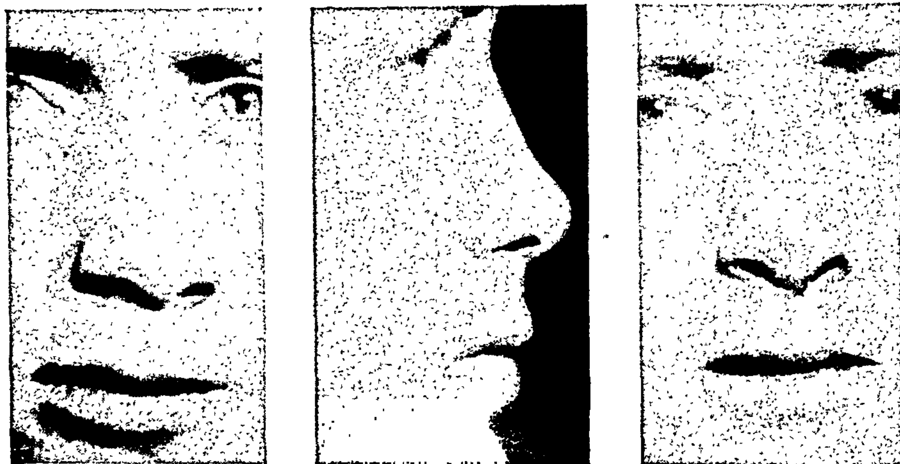


Fig. 55.—*Left,* nasal deformity resulting from simple fracture (lateral force); *middle* and *right,* the appearance after reduction of the fracture (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

Fractures Resulting from Anterior Force. TYPE 1.—The nasal bones may be comminuted, compounded, or displaced posteriorly en masse (flat nose) as is shown in Fig. 56.

TYPE 2.—The nasal (frontal) processes of the maxillae may be fractured along their articulations with the nasal bones and become rotated outward from fracture lines at their bases ("bursting force") (Fig. 57). They may suffer multiple fractures and be driven posteriorly with the nasal bones (flat nose with upturned nostrils).

TYPE 3.—The nasal septum suffers multiple compound fractures in both the bony (perpendicular ethmoid plate) and cartilaginous (quadrilateral cartilage) portions. The fractured fragments frequently override. The cartilaginous septum may suffer greenstick fracture and and become dislocated from its ridge in the vomer.

Fracture of Mandible

See Section II, "Maxillary Surgery."

Fracture of Nose

Do not manipulate or "pack" a nose in the presence of drainage of cerebral fluid. Wait a minimum of ten days after draining ceases.

Reduce the fracture immediately, if possible, but remember that it can be done at any time in the course of two or three weeks. Remember that failure to reduce a fresh fracture requires extensive surgical measures later. The nose is the most prominent facial feature. Marked abnormalities create a definite economic and psychic hazard.

Do not neglect the intranasal condition. Failure to do corrective work necessitates surgical procedures at a later date.

Diagnosis.—Frequently difficult, immediately.

1. Generally, much swelling when first seen. This masks the extranasal and intranasal displacement.
2. Tenderness prevents adequate palpation.
3. Roentgenologic procedures are neither particularly useful nor necessary.
4. If uncertain as to diagnosis, wait until the swelling has subsided.
5. Examine both the external and internal aspects of the nose for displacement and movement. The fracture is frequently compounded intranasally or, at least, the mucosa is torn in some part of the line of fracture.

Factors Producing Fracture.—The displacement of bone and ·tilage depends on the *mass and shape* of the traumatizing object d the *force and direction* of the impact.

Objects having flat contacting surfaces, weight, and a considerable force may produce displacement, and impaction or comminution. These objects and those with irregular and sharp surfaces lacerate the soft coverings. Small objects tend to produce local fractures.

The direction of the force determines the lines of displacement. Such force may be *lateral*—at a right angle to the side of the nose; *anterior*—perpendicular to the nasal ridge; *inferior*—from below in the line of the long axis of the nose (septum and nasal bones); or in a combination of these directions.

Fracture Resulting from Lateral Force.—Nasal (frontal) processes of the maxilla are fractured at their bases and the suture line with the frontal and nasal bones. The nasal (frontal) process proximal to the blow is carried toward the median line to create the typical long (flat) side, and the distal process is carried laterally to create the

bone and the sphenoid bone are frequently fractured with resulting drainage of cerebral fluid.

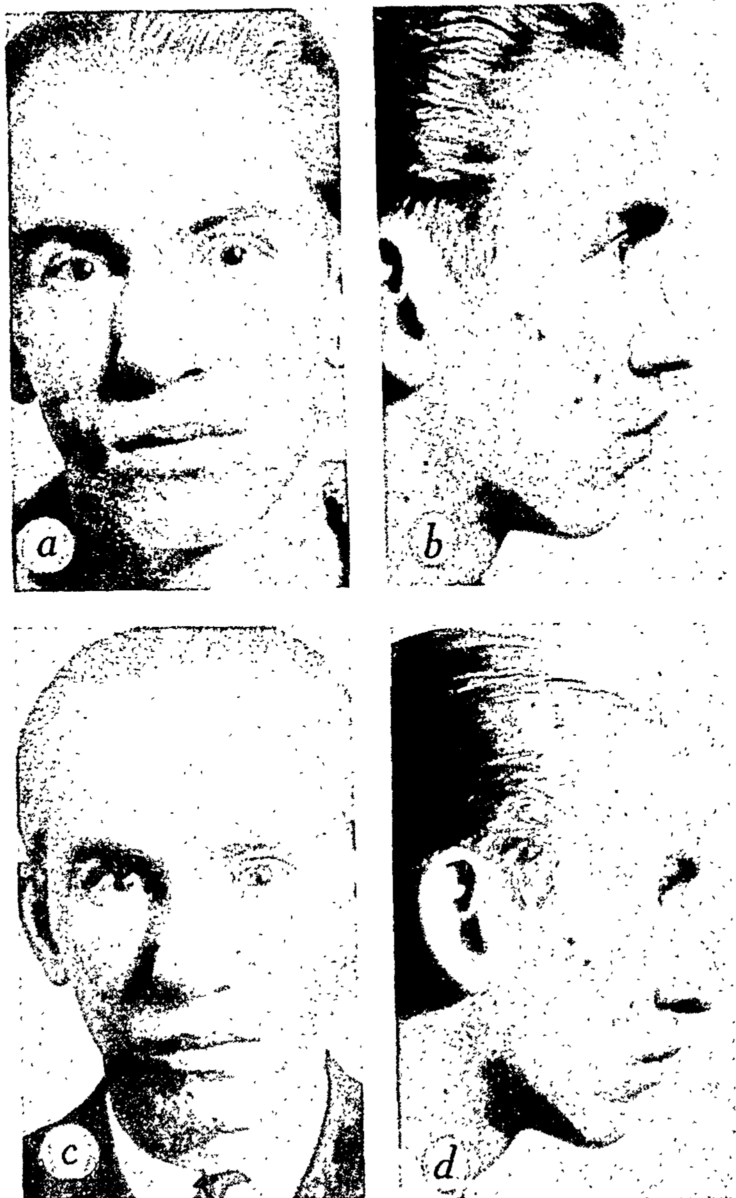


Fig. 57.—Deformity resulting from comminution of the nasal bones and nasal processes (direct anterior "bursting" force). Both nasal processes are displaced laterally. *a*, Anterior and, *b*, lateral views before reduction and reconstruction; *c*, anterior and, *d*, lateral views after reduction and reconstruction (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

Reduction of Nasal Fractures. ANESTHESIA.—The interior of the nose is sprayed with equal parts of *cocaine hydrochloride* (20 per cent) and *epinephrine hydrochloride* (1:1000). The resulting solution

TYPE 4.—The cartilages of the tip, upper and lower lateral, may be dislocated or fractured (Fig. 58).

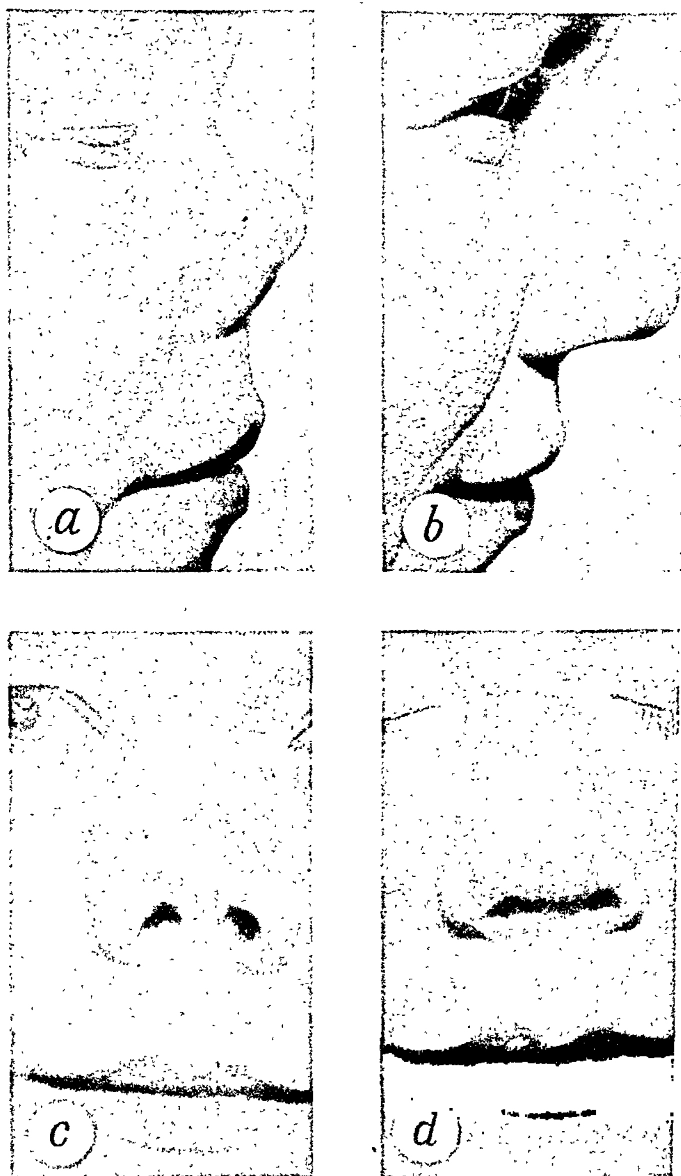


Fig. 56.—Deformity resulting from compound fracture of the nasal bones and nasal processes of the maxillae (force exerted anteriorly and inferiorly). *a*, Lateral view before and, *b*, after reduction; *c*, anterior view before and, *d*, after reduction.

Fractures Resulting from Force from Below.—The displacements are similar to the above. The nose is "pushed back" or flattened.

It is in Types 1, 2, and 3 that the cribriform plate of the ethmoid

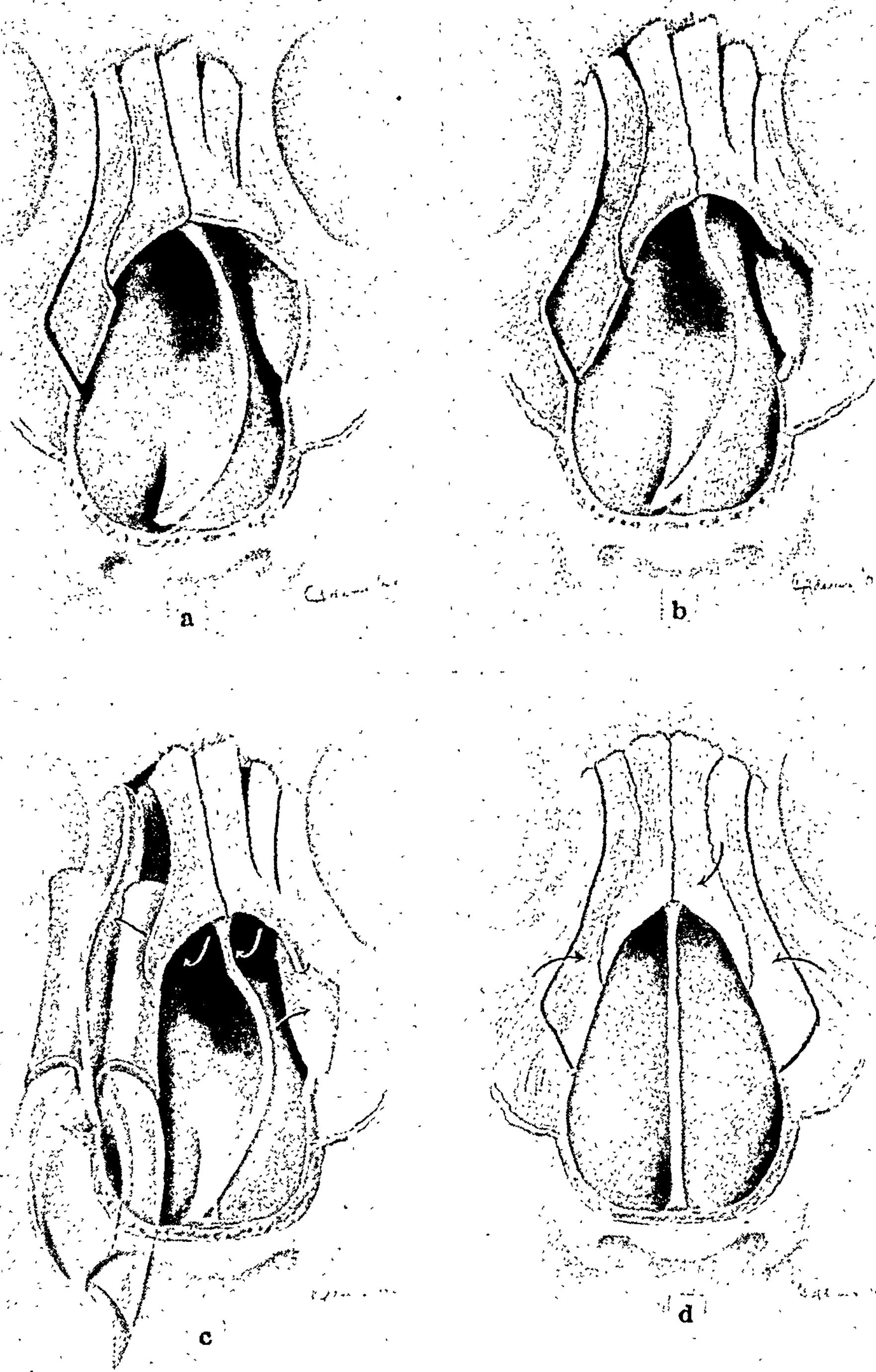


Fig. 59.—a, Simple fracture and lateral displacement of the nasomaxillary articulations and the bases of the nasal processes of the maxillae (lateral displacement); displacement of the nasal septum; *b*, impacted fracture of the nasal bones and nasal processes of the maxillae (lateral displacement); c, Asch forceps with one blade externally and one blade intranasally, grasping the nasal process of the maxilla; the arrows indicate the direction of traction for reduction of the fracture; *d*, replacement of the fractured elements; normal bony arch.

is cocaine hydrochloride 10 per cent in epinephrine hydrochloride 1:2000. Five minutes after spraying, the nose is gently packed with cotton pencils wrung out of the solution. The pencils are placed well upward and backward, as well as along the lower turbinal bone. If the degree of swelling permits, cotton-wound applicators, saturated with epinephrine hydrochloride (1:1000) and rubbed in cocaine powder, may be substituted for the cotton pencils. One is placed over the region of the sphenopalatine ganglion (posteriorly, superiorly, and laterally) and the other upward against the cribriform plate, between the midportion of the middle turbinate bone and the septum (anterior ethmoidal nerve). A cotton pencil is placed on the nasal floor anteriorly to anesthetize filaments from the anterior palatine nerve. The



Fig. 58.—*Left* and *middle*, fracture and displacement of the quadrilateral septal cartilage and the right alar cartilages (direct anterior force); *right*, appearance after reduction and reconstruction (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

external soft parts are anesthetized with 0.5 per cent solution of *procaine* injected at several points along the bases of the nasal (frontal) processes.

PROCEDURE

1. Disjoin and segregate the several bony fragments of the nasal arch.
2. Elevate and straighten the nasal septum. Return the cartilage to its groove in the vomer.
3. Rotate the nasal (frontal) processes inward and mold them into normal contact with the nasal bones.
4. Use light intranasal packing, if required, and an external splint (Figs. 59, 60, 61).

(frontal) processes may now be rotated outward. The nasal septum is straightened and replaced in its groove in the vomer by manipulating and lifting forward and upward with the Asch forceps. A long-bladed nasal speculum is a useful aid in this connection. The nasal (frontal) processes may now be rotated inward and molded into normal contact with the nasal bones.

Light packing with iodoform ribbon gauze may be required to control oozing and to maintain the parts in position. A cotton eye pad is fitted externally to the nose and covered with a copper, sheath splint. This is maintained by an inch-wide strip of adhesive tape. Squeeze the cheeks toward the nose before applying the adhesive tape. This provides sufficient tension to hold the splint and allows for swelling (Fig. 61). Remove the packing in twenty-four hours.

Clear the nose daily with a suction pipet. Do not sponge it internally. Inspect the septum after twenty-four hours for hematoma and drain promptly if it occurs. Do not allow the patient to blow his nose for ten days. Permit him then to *blow both sides at once,* without undue force. Remove the splint permanently at the end of a week or ten days and instruct the casualty not to handle his nose.

Fracture of Zygomatic Bone and Arch

The *incidence* in civil life is 1:3000 cases of fracture of bones of the face.

This bone (malar or "cheek" bone) forms one of the most prominent parts of the facial contour. It is dense and not readily fractured itself. It forms the lateral wall, part of the anterior wall, and part of the floor of the orbit and, with the zygoma, forms a buttress supporting the maxilla.

Articulations.—Four sites of fracture correspond to the articulations of the bone: (1) the frontal process—superior external orbital margin; (2) the orbital process—region of infra-orbital foramen; (3) the zygomatic arch; zygomatic process of the maxilla—anterior antral wall.

Sites of Fracture.—The zygoma may suffer simple fracture of the suture lines and remain in situ, but this is an occasional occurrence. It may be *displaced* as follows:

1. Simple displacement of various degree.
2. Outward (force posteriorly on the zygomatic arch).
3. Medially and superiorly (force laterally and upward). Fracture occurs in the region of the infra-orbital foramen. The point of the fragment may be palpated near the inner canthus.

Asch forceps with rubber tubing over the blades to protect soft parts and any strong, thin-bladed spatula will suffice for *manipulation* (Fig. 60). One blade of the forceps is introduced intranasally on either side; the fragment of the nasal process is grasped firmly and rotated

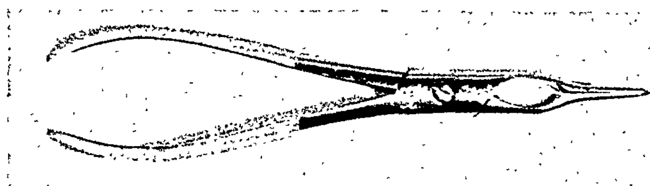


Fig. 60.—Asch forceps.

outward. In the presence of posterior displacement of the nasal bones and impaction, the blades of the forceps are introduced first intranasally, one on either side of the septum, and traction is applied upward and forward. The blade of a spatula is useful in this man-



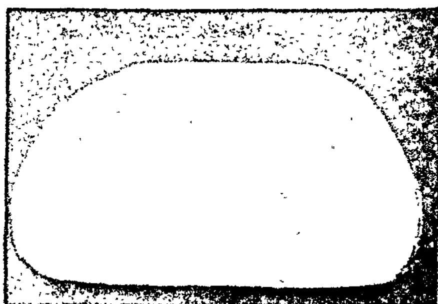


Fig. 61.—*Left*, application of a copper nasal splint over a thick, cotton eye pad; this is fixed in position by a strip of adhesive tape applied to the cheeks after the tissues of the cheek have been moved toward the nose. The traction of the displaced muscles of the cheek provides suitable tension; *right*, a piece of shaped copper sheet (20 gauge) covered with waterproof adhesive material. This is cut from a paper pattern of the nose.

euver. In the event that the frontonasal articulation of the nasal bones has not been fractured, until these bones are freely movable it may be necessary to make a stab incision with a small knife over the glabella and free the bones with a small, beveled chisel. The nasal

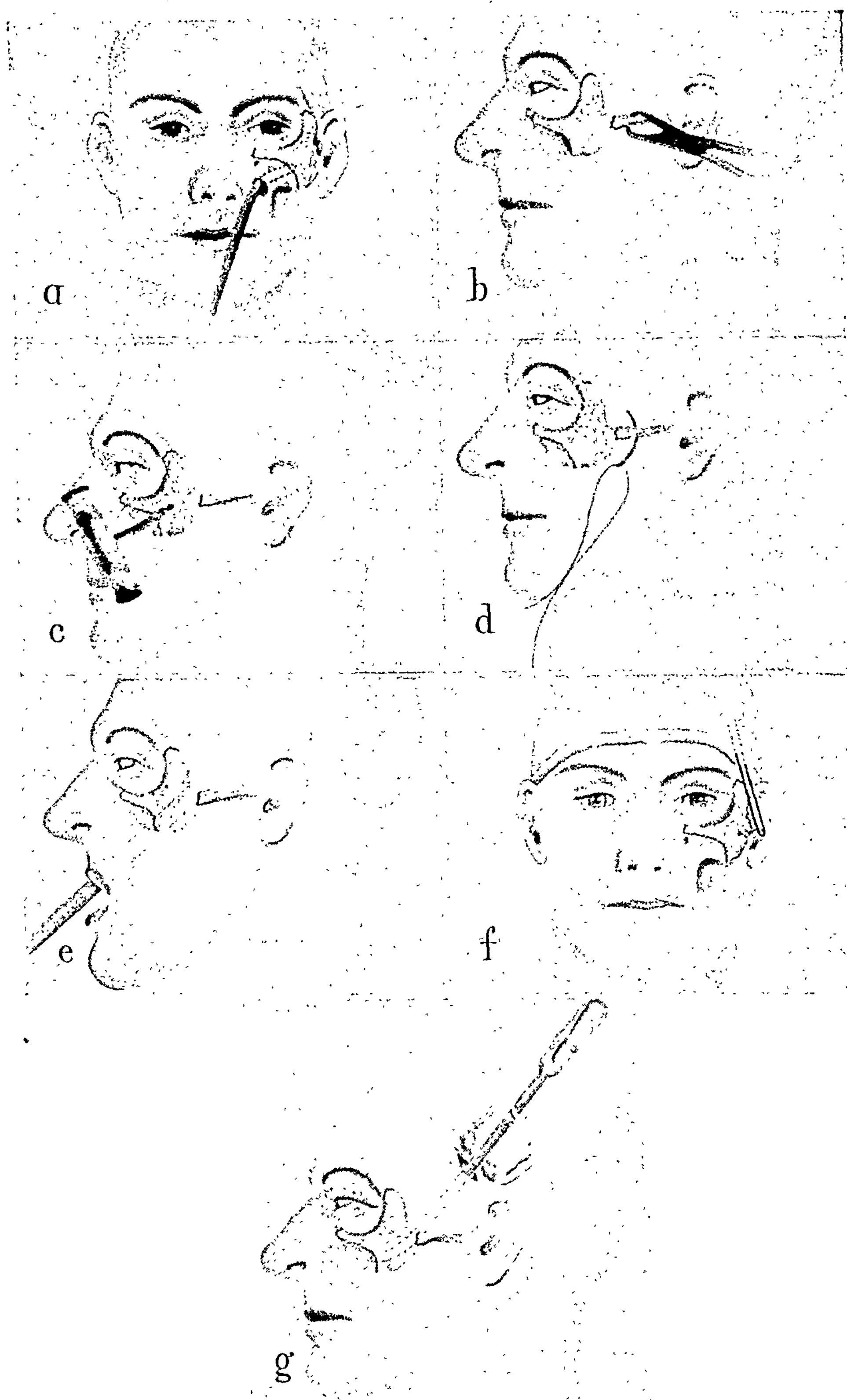


Fig. 62.—Methods of reduction of fracture of the zygomatic bone and arch. a, Antral approach (Lothrop); *b*, external approach (Manwaring-Gill); *c*, external approach (Roberts); *d*, external approach (Matas); *e*, intrabuccal approach (Keen); *f*, skeletal traction (Ivy, Curtis); *g*, temporal approach (Gillies).

4. Backward, downward, and inward (force laterally and downward). This is a common displacement. The articulation with the maxilla remains intact, and a comminuted, impacted fracture of the thin outer wall of the maxillary sinus occurs. The zygoma sometimes occupies the posterior part of the antrum.

Diagnosis.—This is based on the history, local appearance, palpation, and roentgenologic appearance which develops the *signs* and *symptoms* enumerated below.

1. Facial swelling.
2. Depression or distortion of the locality (flatness of the face above and fulness below).
3. Limitation of motion of the mandible resulting from muscular spasm (trismus), mechanical obstructions (depression of the zygomatic arch against the coronoid process), and pain.
4. Ecchymosis.
5. Unilateral nasal hemorrhage (laceration of the lining of the antrum).
6. Infra-orbital anesthesia (injury to the infra-orbital branch of the fifth cranial nerve in the foramen or bony canal).
7. Diplopia (displaced orbital rim and floor with relaxation of the extra-ocular muscles).
8. Emphysema (lacerated antral lining).

Reduction and Management: General Comment.—This has for its purpose the restoration of normal function to the mandible and the eye and normal facial contour.

Reduction should be accomplished as early as possible in order to avoid the difficulties offered by the soft-tissue reaction and the early fixation of the fragments. If immediate reduction is contraindicated, it should be accomplished *within two weeks* in order to avoid an open procedure.

METHODS OF REDUCTION (Fig. 62).—*Matas* passes a curved cutting needle with a stout suture from below upward around the zygomatic arch and uses this to pull through a silver wire, which forms a sling around the bone. Traction is applied. A splint along the arch is held in place by twisting the wire over it.

Manwaring-Gill grasps the fragment with a towel clip or cowhorn dental forceps and manipulates.

Roberts makes a small incision over the bone and inserts an instrument like a corkscrew into the bone for traction and manipulation. This is the method of McCurdy (1923), who used a double-wire coat hook.

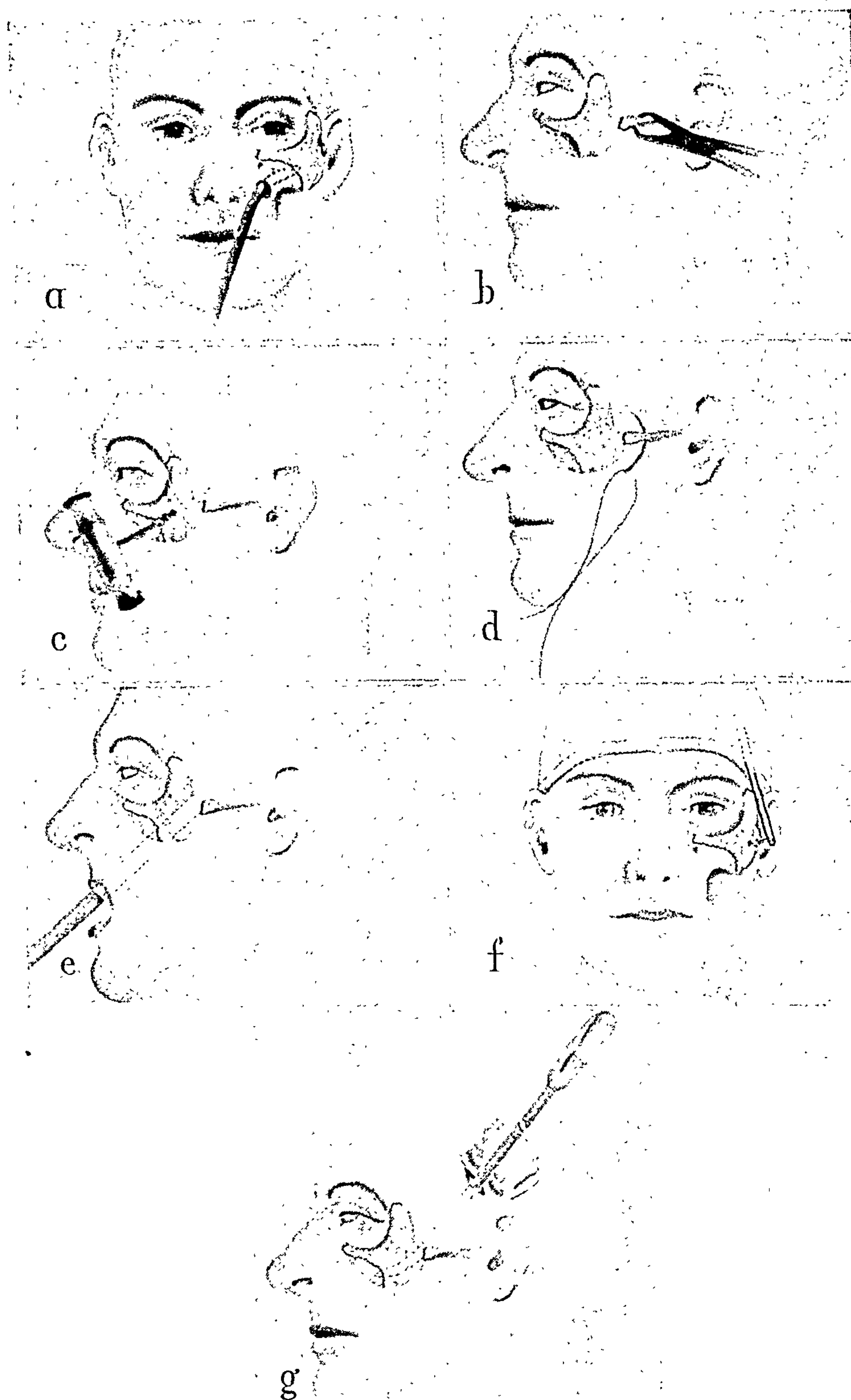


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Ivy and Curtis make a small incision over the bone, drill a small hole in it, and insert a 1-inch, ordinary screweye for manipulation. A plaster head cap (Scogin; see Fig. 198), containing a side arm of heavy wire, is fashioned for use of elastic-band traction (see "Coat-hanger Method," p. 278, and Figs. 179, 180).

For an intrabuccal approach, *Keen* makes a small incision in the buccal fold and inserts a heavy, blunt instrument under the zygomatic process for elevation and manipulation.

For a temporal approach, *Gillies and Kilner* make an incision in the hairline above and in front of the ear, incise the temporal fascia, and pass a curved instrument downward and forward under the zygomatic bone. The skull acts as the fulcrum to permit levering the fragment into place.

For an antral approach, *Lothrop* incises the soft parts along the canine fossa to allow an instrument to be introduced into the antrum. He clears out loose fragments of bone and clot and elevates the fragment with a heavy instrument.

MANAGEMENT.—The procedures of *Gillies* and *Kilner* or of *Keen* will suffice in all ordinary cases. The former procedure is conducted through a clean field and is less likely to be followed by infection. It offers better leverage for reduction. The authors' description is as follows: "A curved incision, 1½ inches long, is made over the temporal muscle and well within the hairline. The edges are retracted; a small incision is made in the temporal fascia; and a long, thin elevator is passed downwards on the surface of the temporal muscle until it lies deep to the displaced bone. When the lever is inserted in the correct fascial plane, it slips under the depressed bone in the most convincing manner, while the operator's hand rests on the firm support given by the skull. The latter should be protected from local pressure injury by a large gauze pad. By careful levering movements the whole bony mass is elevated into correct position, a finger on the various points referred to previously is used as a guide to determine when this result has been achieved."

In those cases wherein the fragments will not remain in place, the method of traction described by *Ivy* and by *Curtis* is employed. The plaster cap (Scogin), which is cumbersome and uncomfortable (Fig. 198) is replaced by the simple, ingenious traction apparatus of *Stout* (Fig. 180). The posterior attachment to the head bandage is shifted laterally to permit a direct pull on the screweye. Traction for four days to a week generally will suffice to locate and fix the fragments in place. Direct wiring is rarely necessary.

A certain group of cases are best managed by *transantral methods*

(Lothrop, Fig. 62) (see "Orbital Reconstruction," Figs. 151, 152). *Packing* in the antrum for a period of days is not approved. Moderate packing for twenty-four to forty-eight hours may be essential in an occasional case. All bone with any attachment is to be conserved and replaced.

A *drainage* opening through the naso-antral wall anteriorly, beneath the lower turbinal bone, is provided and the incision closed with horizontal mattress sutures gently tied. The stitch line is painted with compound tincture of benzoin. A compression pad is placed below the malar prominence and a firm bandage applied about the face and head.

It is sometimes necessary, in old cases, to cut down on the lines of fracture and separate them with a chisel. In these cases wiring frequently is required.

Fracture of the Maxilla

See Section II, "Maxillary Surgery."

Multiple Fractures

These are of the least common occurrence and require the best *cooperative planning* with the dental surgeon. Their management requires a combination of the considerations detailed above and in the section on maxillary surgery. *Do not manipulate these fractured fragments in the presence of fractures of the base of the skull and accompanying injury of the brain until drainage of fluid has ceased and the patient's condition approximates the normal.*

Complications

These comprise injury to nerves such as the infra-orbital and seventh cranial; injury to the eyeball; nasal fractures with loss of bone; and injury to the maxillary sinus with hemorrhage. Wash out clot through a liberal intranasal opening; *do not exert pressure.*

Loss of Bone

This is accompanied by loss of soft parts and essential structures such as motor nerves, muscle, the eye, the nose, and the tongue. The soft parts can be reconstructed; the bone can be replaced by graft or the contour restored with cartilage or dermal graft; motor nerves can be grafted if presence of the nerve is required; the eye can be replaced by a prosthesis in a properly prepared socket (Fig. 150) or the orbit blanked (Fig. 78); the nose can be rebuilt; and the tongue can be repaired to the extent of its remaining portions only.

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A certain group of cases are best managed by *transantral methods*

the crushed extremity and the gradual application of warmth will aid the wounded man in his transportation.

6. With the return of consciousness and in the absence of injury to the gastro-intestinal tract, *warm fluids,* such as tea, coffee, milk, or broth, well salted, given by mouth, will hasten recovery.

Relapsing Stage of Shock

This may occur at any time. It indicates either inadequate therapy or an overwhelming reaction to injury. It represents the failure of the different defense forces to maintain equilibrium. It is, therefore, of grave prognosis and demands instant and constant attention.

Secondary Shock

This may supervene several hours after injury and is the ordinary clinical picture of shock so commonly seen, with its characteristic symptoms of thirst, pallor, sweating, weak rapid pulse, shallow respiration, vomiting, and restlessness. Convulsions are not uncommon and serve as an added omen. There is a declining blood pressure and fall in body temperature; high fever with terminal hyperpyrexia is frequently seen.

This stage of shock may make its appearance with startling suddenness several days, or even several weeks, after injury, especially in those cases in which dehydration is allowed to progress unrecognized through uncompensated loss of body fluids. Here, as in the other stages, the fall of blood pressure "is a sign, not of the onset of shock, but of departed opportunity."

Irreversible Stage

Primary or secondary shock may merge into the irreversible stage, where treatment is valueless. This stage is appreciated by the experienced surgeon and by those who constantly deal with the injured. It is not so well recognized by the younger men. *Signs* of approaching irreversible stage are:

Subjective: Deepening coma; failure of return of reflexes; onset of convulsions.

Objective: Persistent low blood pressure; progressive dilution of blood on account of hemorrhage; progressive peripheral hemoconcentration; increasing cyanosis or pallor.

SHOCK

By John Scudder, M.D.

The prompt and intelligent management of shock in its earliest manifestations is of vital importance in injuries of the face and adjacent parts. Shock suffered by the casualty may be more intractable than that seen in civil practice because of previous exposure, fatigue, lack of nourishment and water, exertion, multiplicity of wounds, and a long period of unrelieved pain and anxiety. In such circumstances, the appreciation of the various stages of shock will make possible more intelligent therapy.

Primary Shock

This is the first stage. It follows immediately after injury. Its degree may vary from syncope to permanent abolition of all reflexes. Its duration depends on the magnitude and location of the injury, the force producing it, and the physical condition of the individual. Clinically it is syncope with the attendant unconsciousness, pallor, sweating, shallow respiration, slow pulse, low blood pressure, and cold skin; all are manifestations, in part, of an overstimulated nervous system. The blood vessels are in constriction; the heart is empty and contracted. Changes have occurred in the body fluids with hemoconcentration in the peripheral vessels and alterations in the cerebrospinal fluid.

Treatment.—This is directed toward the reestablishment of the vital reflexes:

1. Artificial respiration with the air passages clear and tight clothing loosened; oxygen is given if available.
2. Stimulation of the nasal mucous membranes by *errhines*.
3. Support of the *circulation* by:
   (*a*) Correct position; head lowered in pallor; raised in plethora.
   (*b*) Massage of the limbs toward the body.
   (*c*) Administration of *saline solution, serum,* or *plasma,* should these be at hand.
   (*d*) Intravenous injection of a potent *suprarenal cortical extract* along with *salt* to secure relaxation of the spastic vessels and hemodilution.
4. Control of pain by repeated small doses of *morphine*.
5. Prevention of further damage by application of first-aid *dressing, control of hemorrhage,* and *fixation of fractures* before moving the patient. The judicious use of a tourniquet above

hemorrhage, injury, and dehydration are present, the relative condition of hemoconcentration may be evaluated. Failure to employ all these tests results in a false impression of the degree of loss of water. The *erythrocyte count* may be substituted for the specific gravity of capillary blood but is less sensitive. Repeated counts will be of prognostic value. For example: If the initial count is 4,500,000 and a subsequent one in a few hours is 5,400,000—an increase of 900,000 cells per cubic millimeter—a 20 per cent increase has occurred. This "indicates that the mechanism of shock is already operating, that a considerable loss of blood volume has occurred and the condition is, as yet, adequately compensated."

"Hemoconcentration of forty per cent is a grave sign despite any beginning decline in arterial blood pressure." "Concentrations of sixty to seventy-five per cent are characteristic of the terminal stage of shock." *A rising curve of hemoconcentration is as ominous as a declining curve of arterial blood pressure.* It is of more value as it occurs earlier and heralds the approach of the latter. This peripheral concentration is due to a shift of fluid from the blood into tissue cells as well as a loss of circulating plasma due to damage.

Management, Early Preventive

1. Stop hemorrhage; apply first-aid dressing, especially to sucking wounds of the thorax; "splint them where they lie"; restore blood volume by the *proper type of fluid.*
2. Anesthetics contribute to shock. Avoid any surgery *if possible* until the blood picture improves. Employ local anesthesia when feasible; *deep anesthesia,* nitrous oxide, oxygen, and so forth for débridement. (For more on anesthesia, see Section IV.)
3. In using surgical measures avoid further trauma as far as possible. Use sharp hooks or tissue forceps gently in handling tissue.
4. Employ sharp dissection.
5. Use fine hemostats or include a minimum of tissue in the bite.
6. Place ligatures so as to include a minimal amount of tissue.
7. Perform prompt and complete débridement. Conservative or delayed management, or both, favors the development of shock, as the absorption of injured tissue products is a factor in producing shock.
8. Institute adequate drainage.
9. Keep the patient warm during and following surgical procedures.

FAVORABLE SIGNS:

Subjective: Return of reflexes; return of consciousness; cessation of sweating, vomiting, and convulsions; return of kidney function; increase in bodily warmth.

Objective: Increase in pulse pressure; return of blood pressure; decrease in venous pressure; decrease in hemoconcentration of capillary blood following injury or cessation of hemodilution of hemorrhage; change in appearance.

In handling large numbers of casualties, the remedial measures should be used on those who may have a chance; the seriously wounded at least made comfortable. Much blood, serum, and plasma as well as effort have been wasted in trying to correct a hopeless, irreversible condition.

Blood Changes

There are numerous alterations of both physical and chemical character associated with shock. There is the well-known decrease in the concentration of sodium, chloride, and bicarbonate in the plasma as well as a decrease in the number of leukocytes and an increase in the nonprotein nitrogen, blood sugar, and plasma potassium together with a rise in the number of erythrocytes in the peripheral blood. The proteins may be elevated, normal, or low. The same may be said of the concentrations of the above-mentioned ions depending on many factors. Tests to determine these values are time-consuming, require a laboratory, and hence are of little value in the assay of the degree of shock or in its management under field conditions.

Tests for Hemoconcentration.—There are four simple tests in the measurement of hemoconcentration which are of value in just these circumstances; they are easily mastered and require minimal equipment. These tests determine:

1. The specific gravity of capillary blood.
2. Cell volume (by means of a hematocrit).
3. The specific gravity of plasma.
4. The total plasma proteins.

The first measures hemoconcentration in the *peripheral circulation* while the three others measure the state of the *venous or central circulation.* The tests are easily done; they predict the changes which will appear in the concentrations of salt in the blood; they *foretell by hours that the blood pressure is going to fall;* on account of their sensitivity they can differentiate between shock attributed to hemorrhage and that attributable to injury. In complicated cases, wherein

hemorrhage, injury, and dehydration are present, the relative condition of hemoconcentration may be evaluated. Failure to employ all these tests results in a false impression of the degree of loss of water. The *erythrocyte count* may be substituted for the specific gravity of capillary blood but is less sensitive. Repeated counts will be of prognostic value. For example: If the initial count is 4,500,000 and a subsequent one in a few hours is 5,400,000—an increase of 900,000 cells per cubic millimeter—a 20 per cent increase has occurred. This "indicates that the mechanism of shock is already operating, that a considerable loss of blood volume has occurred and the condition is, as yet, adequately compensated."

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6. Place ligatures so as to include a minimal amount of tissue.
7. Perform prompt and complete débridement. Conservative or delayed management, or both, favors the development of shock, as the absorption of injured tissue products is a factor in producing shock.
8. Institute adequate drainage.
9. Keep the patient warm during and following surgical procedures.

10. Give saline solution intravenously before the patient leaves the table, if indicated.
11. Administer a transfusion of blood plasma if shock threatens.

Treatment of Secondary Shock

(See also "Primary Shock," p. 76.) The aim of treatment in secondary shock is to restore blood volume with the proper type of fluid. Any measure which brings cell water into the circulating system in large amounts, whether this be done by loosening of a tourniquet, by too energetic warming of the patient, or by flooding the system with cell water through the injudicious use of hypertonic solutions, especially hypertonic solutions made up with substances of high molecular weight (concentrated serum or plasma in large amounts), is to be strongly deprecated.

Blood Plasma or Serum.—This is the most nearly ideal and valuable of the various agents. It should be given early, at the first evidence of hemoconcentration. A transfusion of plasma at this stage is better than heroic efforts later. In many cases, the patient will recover if he can be sustained for a few hours.

Blood Transfusions.—These are indicated in shock due to both hemorrhage and trauma. In each, the giving of *saline* solution will augment the beneficial effect. Five hundred cc. of blood should be given with every 500 cc. of plasma or serum. Fresh blood is to be preferred to blood stored too long.

Oxygen.—Cells are injured through anoxia; the early giving of oxygen is important. *Its use after the blood pressure has fallen markedly is entirely useless.*

Salt.—Intravenously administered physiologic saline solution will replace fluid and restore circulating efficiency in the early stages of shock; its effects are not so nearly permanent as those of blood or plasma. *Sodium salts* should be given by vein, by rectum, by mouth, or by clysis, or by all of these routes, in amounts ranging from 10 to 30 gm. a day. This will mitigate the traumatic toxemia of injury.

Suprarenal Cortical Extract.—This "vital hormone" is specifically indicated in shock; its actions are manifold; a few are stated. In adequate doses intravenously it will cause dilution of blood with a decrease in hematocrit reading and peripheral hemoconcentration; it will relax smooth muscle, deposit glycogen in the liver, and raise the depressed basal metabolic rate; further, by its action on the kidney it causes retention of sodium and an output of potassium in the urine, thus bringing toward normal the altered concentrations of salt in the blood. Recent experimental evidence suggests that by its action

capillary atony is decreased with the return of the sequestrated blood to the circulation.

Summary

Remove the cause; secure adequate elimination by kidney; maintain the optimal environment for normal cell function; build up blood volume with the right type of fluid; "set nature at rights"; "maintain action, not force it."

BURNS

Improper or inadequate first treatment adds greatly to the danger and difficulty of the subsequent management.

Immediate effort should be directed toward the prevention or treatment of shock, prevention of infection, and production of an aseptic, protective coagulum.

Immediate Care

1. Do not neglect the patient's *general condition* and consider the burned area only.
2. *Do not permit shock to develop—prevent it* (p. 79).
3. Do not neglect initial and subsequent examinations of *blood*.
4. Do not disturb *clothing* until the casualty is hospitalized.
5. Do not apply *greasy substances* or cotton to the burned area.
6. Administer *morphine* generously.
7. Wrap in a wet sheet, if possible.
8. Hospitalize, at once.

Hospital Care

1. Administer *morphine* generously, to limit pain.
2. Prevent or treat *shock* (p. 76). The presence of shock is of more immediate importance than the local lesion.
3. Remove *clothing* gently. This should be done under deep anesthesia (Section IV) if the burn is extensive. It may be done well in a tub filled with saline solution. Good judgment may leave the clothing untouched until required treatment is instituted.
4. Examine blood for *hemoconcentration.*
5. Give transfusion of *blood plasma,* if cell concentration is imminent or present.
6. Apply external *heat.*
7. Give adequate *fluid* by mouth or *saline solution* with *acacia* intravenously, or both. Insure a daily output of 1500 cc. of urine.

10. Give saline solution intravenously before the patient leaves the table, if indicated.
11. Administer a transfusion of blood plasma if shock threatens.

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(See also "Primary Shock," p. 76.) The aim of treatment in secondary shock is to restore blood volume with the proper type of fluid. Any measure which brings cell water into the circulating system in large amounts, whether this be done by loosening of a tourniquet, by too energetic warming of the patient, or by flooding the system with cell water through the injudicious use of hypertonic solutions, especially hypertonic solutions made up with substances of high molecular weight (concentrated serum or plasma in large amounts), is to be strongly deprecated.

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Other unhealed areas may be dressed appropriately if epithelization is occurring; otherwise, they must be grafted.

Other Management.—The extent and location of the lesion and other circumstances may cause the surgeon to choose the use of hypertonic *saline baths* and *dressings* to promote granulation and permit early skin grafting in lieu of tanning. This, however, is not considered as a general management.

"Don't's"

1. Don't tan or cover an area which has not been subjected to débridement or which is infected.
2. Don't leave the crust on an infected area.
3. Don't produce a thick, nonpliable crust on fingers or other flexor surfaces.
4. Don't utilize boric or picric acids on extensive burns; absorption may produce toxic nephritis.

INFECTIONS OF MOUTH AND NECK

Landmarks

1. The angle of the jaw marks the lower limit of the pharyngomaxillary space.
2. The junction of the submental area and the vertical plane of the neck locates the hyoid bone.
3. The upper margin of the thyroid cartilage is the point of bifurcation of the carotid artery. It is at the level of the fourth cervical vertebra.
4. The cricoid cartilage locates the sixth cervical vertebra and the beginning of the esophagus. This is important in periesophageal abscess.
5. The suprasternal fossa (Burns' space) is easily recognized.
6. The midpoint of the sternocleidomastoid muscle between the mastoid process and the sternal attachment marks the emergence of the cervical nerves along the posterior border of the muscle.

Cervical Fascia

Viewed from a surgical standpoint, the cervical fascia creates compartments with consequent intervening spaces as the result of enclosing groups of muscles, vessels, nerves, and glands. Extension of pus is limited laterally by these fascial envelopes, but pus travels readily downward and upward along the fascia, the muscles, and the vessels.

The neck can be visualized as a cylindrical compartment bounded

8. Administer *oxygen,* if anoxia follows cell concentration. It is of value in the early stage only.

Management of Local Lesion

"Aseptic methods are always more important than antiseptic solutions." Regard the burned area as a surgical wound and treat it accordingly.

Débridement.—This should be performed under *deep anesthesia* or local anesthesia (blocking or infiltration) if the area permits. It must be done thoroughly and judiciously. It is better to err on the side of incompleteness than to destroy function further. Scrub gently with gauze and soap. Flush thoroughly with saline solution. Remove adherent debris cleanly with sharp instruments. *The toxins of destroyed tissue cause and maintain shock.*

Tanning.—This results in a protective coagulum which relieves pain, prevents loss of fluid, and aids in preventing infection and in reducing the absorption of toxic substances. Tanning can be accomplished in one of three ways, in all of which fresh 5 per cent *tannic acid* solution is used: (1) immersion in a bath; (2) application of a wet dressing; (3) spraying. Apply the spray at intervals of ten or fifteen minutes until a complete, thin coagulum is obtained. Dry. Apply fresh 10 per cent *silver nitrate* solution directly with gauze or atomizer. This hastens tanning and produces a thin, flexible, tough coagulum. Don't use tannic acid in solution about the eyes. Apply it in the form of a gel. *Flexor surfaces* must be lightly covered with a flexible coagulum and frequently inspected.

Administer *sulfonamide drugs* in adequate dosage to maintain a proper concentration in the blood. The surface of the wound may be dusted with the powdered drug before tanning. The tanned area must be inspected frequently for moist spots. These should be dried promptly with a warm-air blower and sprayed with *silver nitrate.* Loose, elevated spots in the crust must be removed to prevent collection of fluid and retention of infection. These are tanned again, *if the area is clean.* Appropriate *extension apparatus* (banjo splints, and so forth) is employed early to prevent deformities.

A major cause of deformity is long-continued granulation. The organization of scar in the base of such granulation and its contraction determine the deformity. Areas of this kind must be grafted promptly

Areas about flexor surfaces, which are unhealed when the coagulated crust separates, must be grafted promptly (p. 55) to prevent contraction.

vical fascia. The incision is placed above the superior border of the digastric muscle and may extend from the chin to the angle of the jaw, depending on the extent of involvement (Fig. 63, *1*). The capsule of the gland is incised when the gland itself is involved.

Superficial purulent collections in the floor of the mouth may be drained intra-orally. A deep collection of pus anteriorly and medially, both above and below the muscle, is best approached through a curvilinear incision below the chin. The mylohyoid muscle is divided vertically along the raphe for drainage of deep lingual infection. This cutaneous incision precludes an elevated scar band following healing.

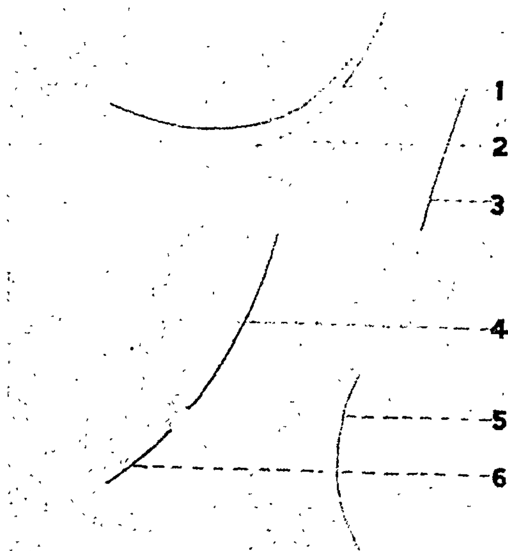


Fig. 63.—Lines of incision for drainage. *1*, Submaxillary gland and space; *2*, pharyngomaxillary space; *3*, lateral pharyngeal space; *4*, periesophageal space —anterior; *5*, periesophageal space—posterior; *6*, mediastinum.

Tracheotomy should be considered early in cases in which the tongue is involved.

Pharyngomaxillary Space (Parapharyngeal Space)

This potential space exists only when it is occupied by fluid. The anterior compartment is the real pharyngomaxillary space, and the posterior compartment is an extension of the carotid sheath.

The Anterior Compartment.—This extends from the base of the skull downward to the level of the angle of the jaw. Its boundaries are as follows:

by the superficial layer of the deep cervical fascia and including smaller fascial enclosed compartments containing viscera, vessels, and nerves, and such other structures as the carotid sheath, a visceral compartment containing the larynx, trachea, and esophagus, and the large compartment posterior to the prevertebral fascia.

Submaxillary Space; Floor of Mouth; Tongue

The mylohyoid muscle is the important structure influencing the location and travel of pus. The plane of this muscle floor slants downward and forward. Fluid tends to gravitate toward the chin. The posterior limit of this muscle is the plane of the third molar tooth. Pus can flow over this posterior edge into the neck. The *submaxillary gland lies below,* and its duct (Wharton's) above, this muscle. The *sublingual gland lies above* this muscle and immediately above the submaxillary gland.

The fascia of the submaxillary space comes from the covering of the hyoid bone. It splits to invest the gland. The mesial layer covers the inferior surface of the mylohyoid muscle, and the outer layer attaches to the lower edge of the mandible.

The lymphatic structures drain into the submental, submaxillary, pharyngeal, and deep cervical channels. Infection in the submaxillary fossa may be parenchymatous (glandular) or periglandular. The clinical differentiation depends on the presence of pus in Wharton's duct. Drainage by this channel may be adequate in the glandular type of suppuration.

Ludwig's Angina.—To mention this type of purulent inflammation seems relevant here. The *symptoms and signs* of the condition are as follows:

1. Acute illness, with chill and rise in temperature.
2. Pain in the floor of the mouth and in the tongue.
3. Painful swallowing and respiration.
4. Tenderness on palpation.
5. Cellulitis in the floor of the mouth and under the chin.
6. Swelling with marked displacement of the tongue.

Abscess of Base of Tongue.—This is another relevant type of purulent inflammation. Its *symptoms and signs* follow:

1. Pain and restricted motion.
2. Dysphagia.
3. Difficulty in respiration, which rapidly increases, because of edema of the epiglottis and laryngeal structures.

Surgical Drainage.—The submaxillary space is drained by incision of the skin, superficial fascia, platysma muscle, and deep cer-

copharyngeal aponeurosis. The *inferior portion* of this space ends at the beginning of the esophagus (sixth cervical vertebra; cricoid cartilage). Its anterior and posterior boundaries are the same as above. It is limited laterally by the alar fascia and the carotid sheath.

Infection in the retropharyngeal space extends either upward or downward in its early course and manifests itself *in the neck* (laterally) *late* in its history. Infection in the lateral space manifests itself *in the neck early* in its progress and extends laterally. Such infections travel behind the carotid sheath in the direction of the posterior border of the sternocleidomastoid muscle.

Surgical Drainage of Retropharyngeal and Lateral Pharyngeal Abscesses

Retropharyngeal Abscess.—Place the patient in the Trendelenburg position. Incise through the pharyngeal wall. Apply suction if it is available.

Lateral Pharyngeal Abscess.—In an *early stage* employ the intraoral approach. Incise mucosa and aponeurosis and then proceed with blunt separation. Avoid injury to large neighboring vessels. In a *late stage* (swelling in posterior triangle of the neck), incise along the posterior border of the sternocleidomastoid muscle, over the point of maximal swelling, and follow the fascial cleavage backward and medially to the prevertebral fascia (Fig. 63). Avoid the cervical nerves coming around the border of this muscle at its midpoint.

Periesophageal Space

The esophagus is surrounded by loose areolar tissue throughout its length. The posterior wall of the esophagus lies on the prevertebral fascia and forms the front boundary of the prevertebral space. This is a continuation of the retropharyngeal space and continues downward below the clavicles as the posterior mediastinum. The anterior wall is formed by the pretracheal fascia which extends medially from the carotid sheath. It envelops the thyroid gland and passes under the depressor muscles of the hyoid bone on to the trachea to fuse with the fascia from the opposite side. The lateral lobes of the thyroid gland meet the esophagus and form part of the lateral boundary of this space. The superior limit is the attachment of the fascia to the hyoid bone.

This space contains the larynx, recurrent laryngeal nerves, the thyroid gland, the inferior thyroid vessels, and the esophagus.

Infection from injury to the posterior wall travels readily and rapidly into the *mediastinum.* It extends laterally along the preverte-

ANTEROMEDIAL WALL.—Buccopharyngeal fascia and anterior pharyngeal wall.

ANTEROLATERAL WALL.—Fascia of internal pterygoid muscle.

POSTEROLATERAL WALL.—Fascia of parotid gland in its lower portion—it is absent above; fascia of the styloid process and its muscles; and part of anterior wall of carotid sheath.

POSTEROMEDIAL WALL.—Alar fascia.

Posterior Compartment.—This is a separate anatomic entity (carotid sheath). It is closely related clinically and pathologically to the anterior compartment. Pus may find its way into the neck by following the anterior wall of the sheath and may involve its vascular content (jugular thrombosis).

Retropharyngeal Spaces

The pharynx extends from the inferior surface of the sphenoid bone to the beginning of the esophagus (sixth cervical vertebra). The wall of the pharynx, composed of mucous membrane, aponeurosis, constrictor muscles, and buccopharyngeal fascia, constitutes the anterior wall of the retropharyngeal space. This fascia is derived from the prevertebral fascia. The posterior wall is composed of the prevertebral fascia and muscles. Loose areolar tissue between the two layers of fascia permits movement of the pharynx. The inferior continuation of the prevertebral fascia extends to the posterior mediastinum.

The prevertebral muscles are determining factors in the direction of extension and localization of collections of pus. The longus colli muscles extend upward and downward in the midline (retropharyngeal). The longus capitis (superiorly) and the scalenus anterior muscles (inferiorly) extend downward and outward. Infections, spreading laterally, follow these muscle sheaths behind the carotid sheath to the posterior border of the sternocleidomastoid muscle.

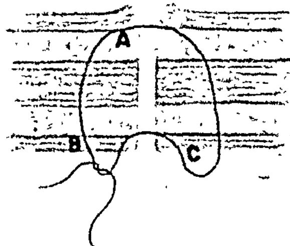
Lateral Pharyngeal Space

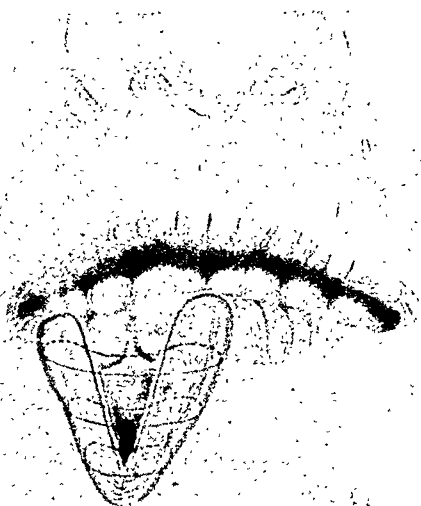
This space is actually that portion of the retropharyngeal space which extends beyond the lateral limits of the pharynx. The alar fascia determines the existence of this space. It is an extension connecting the visceral fascia of the pharynx and the carotid sheath. The *upper portion* of this space extends from the base of the skull downward to the level of the angle of the jaw. Its lateral boundaries are the carotid fascia and the pharyngomaxillary space; its posterior boundary, the prevertebral fascia, and its anterior boundary, the buc-

CHAPTER III

CHEILOPLASTY

THIS is the first of eight chapters dealing with methods of surgical reconstruction of the following: lips, cheeks, nose, eyelids, ear, scalp





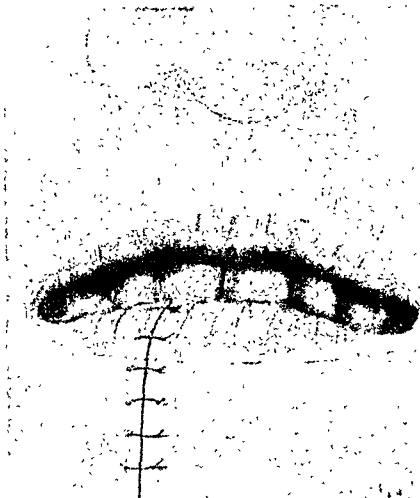


Fig. 64.—Repair of defect of lower lip. *Left,* disposition of the relaxing and approximating sutures. *Top,* detail of the suture; A, skin; B, mucous membrane; C, a vertical mattress suture. This suture produces the desired relaxation and approximation of the muscular layers and the mucous membrane. It everts also the edges of the mucosa. It prevents cutaneous scar by permitting early removal of cutaneous sutures. *Right,* the skin approximated with horsehair sutures.

and cranium, the neck, and the palate and premaxillary portion of alveolar process. (For anesthetic procedures see Section IV.)

bral fascia to appear behind the posterior border of the sternocleidomastoid muscle.

Surgical Drainage.—Incise along the posterior border of the sternocleidomastoid muscle, down to the prevertebral fascia, and follow this plane medially with the finger until pus is located (Fig. 63, *5*).

Infections from Anterior Esophageal Wall and Trachea

These extend anteriorly and laterally under the thyroid gland and are limited by the carotid sheath. They manifest themselves along the anterior border of the sternocleidomastoid muscle and are best approached along this line (Fig. 63, *4*).

Surgical Drainage.—Incise along the anterior border of the sternocleidomastoid muscle, through the superficial layer of the deep fascia. Separate the tissues of the space between the carotid sheath and the gland and incise the thickened pretracheal fascia. Extend bluntly (finger). If the thyroid gland is involved, its capsule must be incised also.

Cervical Mediastinotomy

This may be performed on either side of the neck. The right is preferable when election of site may be made.

A curvilinear incision is carried along the anterior border of the sternocleidomastoid muscle, down to the clavicle, and then laterally along the clavicle (Fig. 63, *6*). The pleura is high in the right side of the neck, and care must be exercised to avoid it. The trachea and esophagus are exposed and separated from the prevertebral fascia. The dissection is continued along this fascia into the superior mediastinum, bluntly, with the finger. This dissection is directed between the big vessels with this approach. The dissection on the left side is carried lateral to the carotid artery and jugular vein.

A tube is inserted and continuous suction applied with the patient in the Trendelenburg position.

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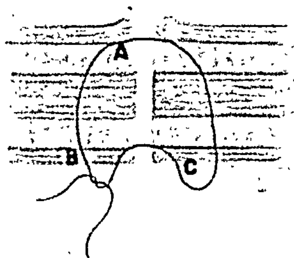






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and cranium, the neck, and the palate and premaxillary portion of alveolar process. (For anesthetic procedures see Section IV.)

SIMPLE SUTURE

The skin is dissected from the underlying fascia and muscle for a short distance around the entire border of the wound.

Vertical mattress sutures of silk (noncapillary) relax and approximate the muscle and the mucosa. The lowest suture is passed first. The needle is inserted about ½ inch (about 1.3 cm.) from the mucosal border (Fig. 64, *top,* B), carried through the muscle *to the skin* (Fig. 64, *top,* A) to emerge at the edge of the wound. It is reintroduced between the skin and the muscle on the opposite side of the wound and passed through the muscle and mucosa to a point about ½ inch from the margin of the wound. It is then passed diagonally through the mucosa to the free margin of the wound and finally through the mucosa on the first side. A second and a third stitch are passed in a similar manner. The stitches are tied sufficiently tight to approximate accurately the cut muscular surfaces. The skin is closed with *interrupted horsehair sutures* or a *subcuticular stitch.* The former are removed on the second day, and the line of incision is supported with *gauze collodion strips* (Figs. 20, 22).

ELEVATION AND DEPRESSION OF ANGLE OF MOUTH

Tissue Loss and Deformity

Skin and superficial fascia; scar and contraction (Fig. 65).

Requirements

Removal of scar tissue, introduction of sufficient skin and subcuticular tissue to repair the defect.

Procedure

This correction is accomplished in a single procedure. The elevation or depression of the angle above or below its normal plane determines the width of the interpolated flap required (Fig. 65, c, B). The length of the flap is determined somewhat by the degree of the elevation or depression.

Elevation of Angle of Mouth.—To correct elevation of the angle of the mouth, make a curved incision, beginning near the midpoint of the lip. Carry it along the mucocutaneous border of the upper lip to the commissure, around the commissure, and along the mucocutaneous border of the lower lip for a sufficient distance to produce a flap of the required length. Carry it downward for the desired width and laterally to complete the outline of the flap and also that of its base.

Dissect the skin and underlying fat of the flap. Dissect the elevated angle of the mouth free from the surrounding scar. Remove the



Fig. 65.—Correction of elevation of the angle of the mouth by means of an interpolated flap. *a*, A third- and fourth-degree burn; destruction of the skin of the eyelids with resultant ectropion; scar contracture distorting the mouth; *b*, appearance after restoration of the angle of the mouth to its normal position; thick split skin graft covering the granulated area and the eyelids; *c*, outline of an incision to free the tissues about the angle of the mouth, A, and to produce a suitable flap, B, for transposition; *d*, transposition of mouth tissues and the flap; simple suture (*a* and *b* from Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

scar tissue in the area. Transpose this portion of the mouth and the flap. Close the approximating edges with interrupted horsehair su-

tures. Paint the stitch line about the mouth with compound tincture of benzoin. Cover the stitch line of the lip with a gauze dressing moist with alcohol.

Depression of Angle of Mouth.—Correction of depression of the angle of the mouth may be accomplished by the transposed flap procedure pictured in Fig. 65. It is simply a reversal of what is shown in that figure.

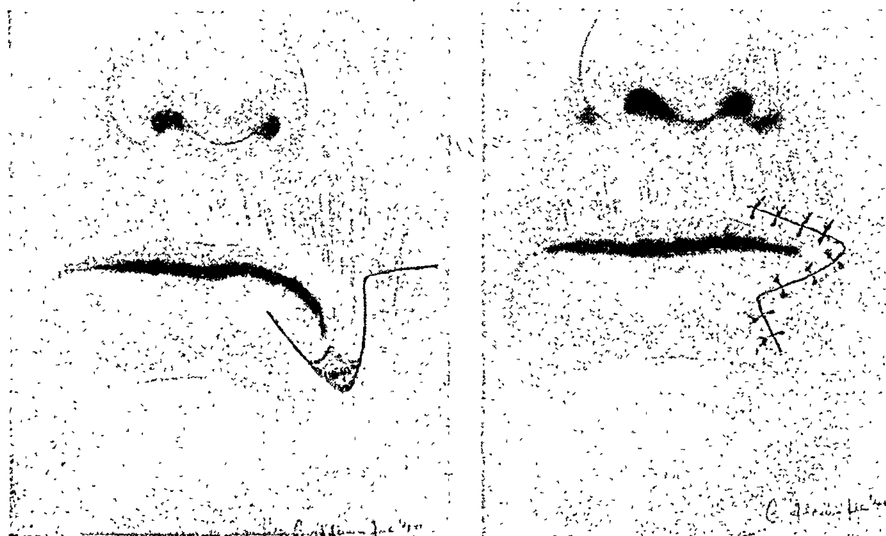


Fig. 66.—*Left,* depression of the angle of the mouth. Outline of a suitable flap for its correction; *right,* transposition of flap and angle of mouth; suture.

Fig. 66 depicts another simple method of correction which utilizes the tissues about the angle of the mouth as the transposed flap.

ECTROPION OF LIP

Ectropion of the lip is a distortion (eversion) resulting from loss of tissue and formation of scar with ultimate organization and contraction. The loss may be superficial or deep. It may be submental and cervical (Fig. 67, *upper*); it may occur about the margin of the lip (Fig. 67, *lower left*); or it may involve the tissues of the entire lip (Fig. 67, *lower right*). A combination of these various losses is pictured in Fig. 68.

This distortion is preventable to a large degree by proper management at the time of injury; the appropriate treatment of burns, including grafting at the proper time; the thorough débridement and immediate approximation of lining and skin covering in the case of full-thickness losses; or immediate repair when this is possible.

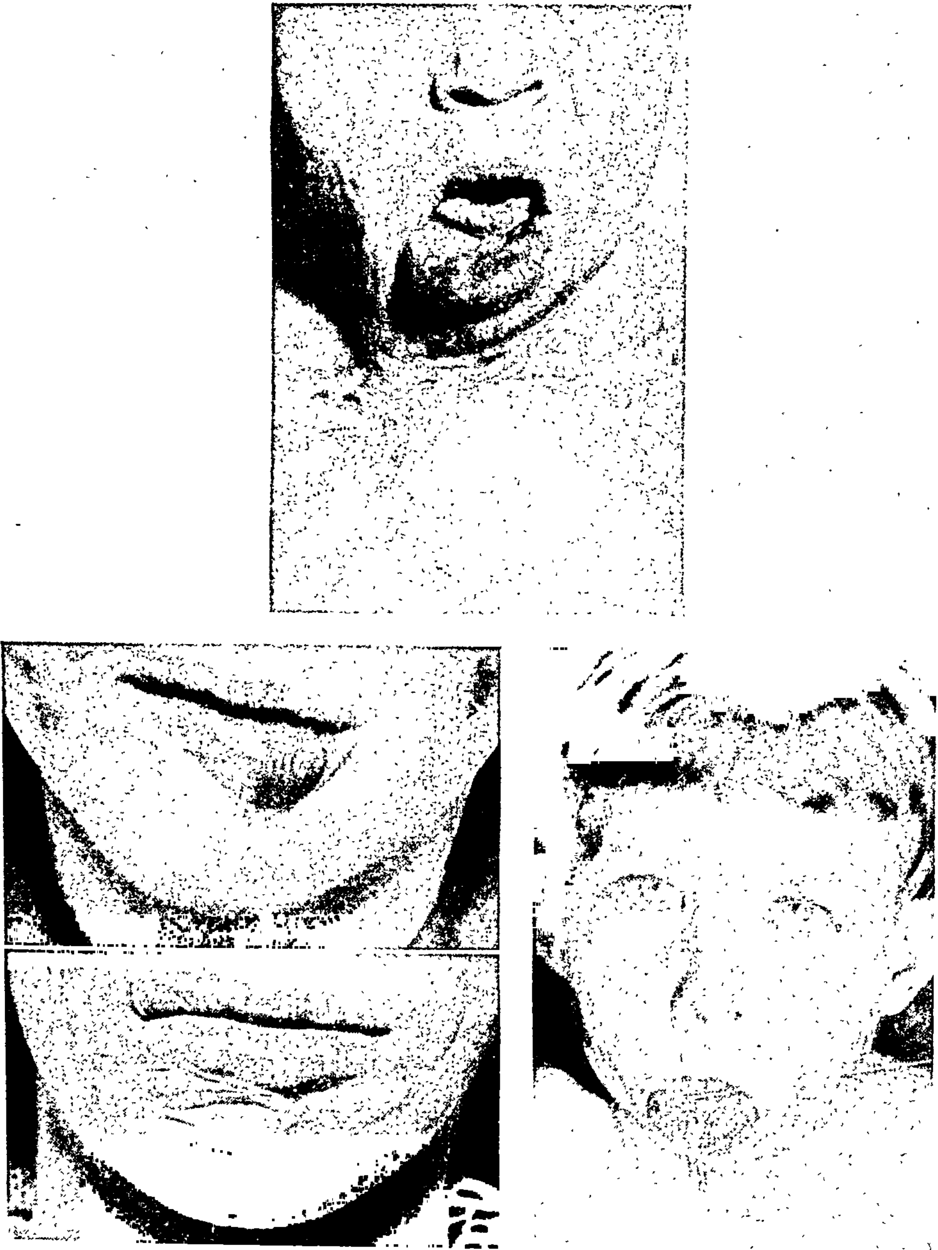


Fig. 67.—Ectropion. *Upper,* the result of destructive scarring and contraction in the submental and cervical regions; note that traction of the scar has distorted the mental region of the jaw and everted the two central teeth; *lower left, above,* simple ectropion due to tissue loss and scar contraction along the mucocutaneous junction; *lower left, below,* correction with an interpolated flap from the cheek; *lower right,* total ectropion resulting from destruction of the skin of the lower lip and subsequent scar contraction.

The constant, powerful traction by a scar everts, distorts, and permanently stretches the mucosa, making it difficult in some instances to return the buccal mucosa to its normal location. Some degree of

intra-oral correction is required frequently to maintain the border of the lip in its normal position (Fig. 67, *lower right,* Fig. 68). The traction by scar prevents development of bone in some instances (Fig. 68; see also Fig. 166). It occasions loss by pressure atrophy in other instances. It may distort the existing bone, as can be seen from the position of the teeth in Fig. 67, *upper.*

The *requirements* for support and cosmetic result may be any or all of the elements of the lip: skin, supporting tissue, lining, bone or cartilage, or both bone and cartilage. It is desirable that the required tissues be obtained from the locality rather than introduced from a distance. Transplanted skin, either as free graft or as pedicled flap, presents contrasts in color so frequently that it is undesirable. It may, however, become a necessary choice.

OBLITERATION OF CHIN AND CHINLINE OF THROAT

Reconstruction in some cases can be effected by utilizing tissues of the locality and dermal grafts (Fig. 68).

Loss

Skin and superficial fascia of lower lip, face, and neck.

Requirements

Release of contraction caused by scar and removal of scar; addition of skin to release the mucosa and elevate it to its proper level; readjustment of the cervical skin to produce a chinline; supporting tissue placed in the mental region to produce a chin; correction of the depressed angles of the mouth.

Procedure

Stage 1.—Incise the scar around the mucosa of the lower lip. Dissect the mucosa up to the level of the angles of the mouth. Excise about 1 inch (about 2.5 cm.) of the free border of the mucosa. This has been stretched until it presents an excess too great for adjustment. Incise, elevate, and rotate a flap of proper dimensions from the left cheek and neck to fill the defect on the lower lip (see also Fig. 75, *c, d, e,* which represent repair of an upper lip). Suture the approximating edges with interrupted stitches of horsehair. Undercut the skin bordering the defect resulting from elevation of the flap and approximate with interrupted horsehair sutures (see also Fig. 75, *e*).

Stage 2.—The minimal interval between Stages 1 and 2 is six weeks. The purpose in Stage 2 is to reconstruct the neck.

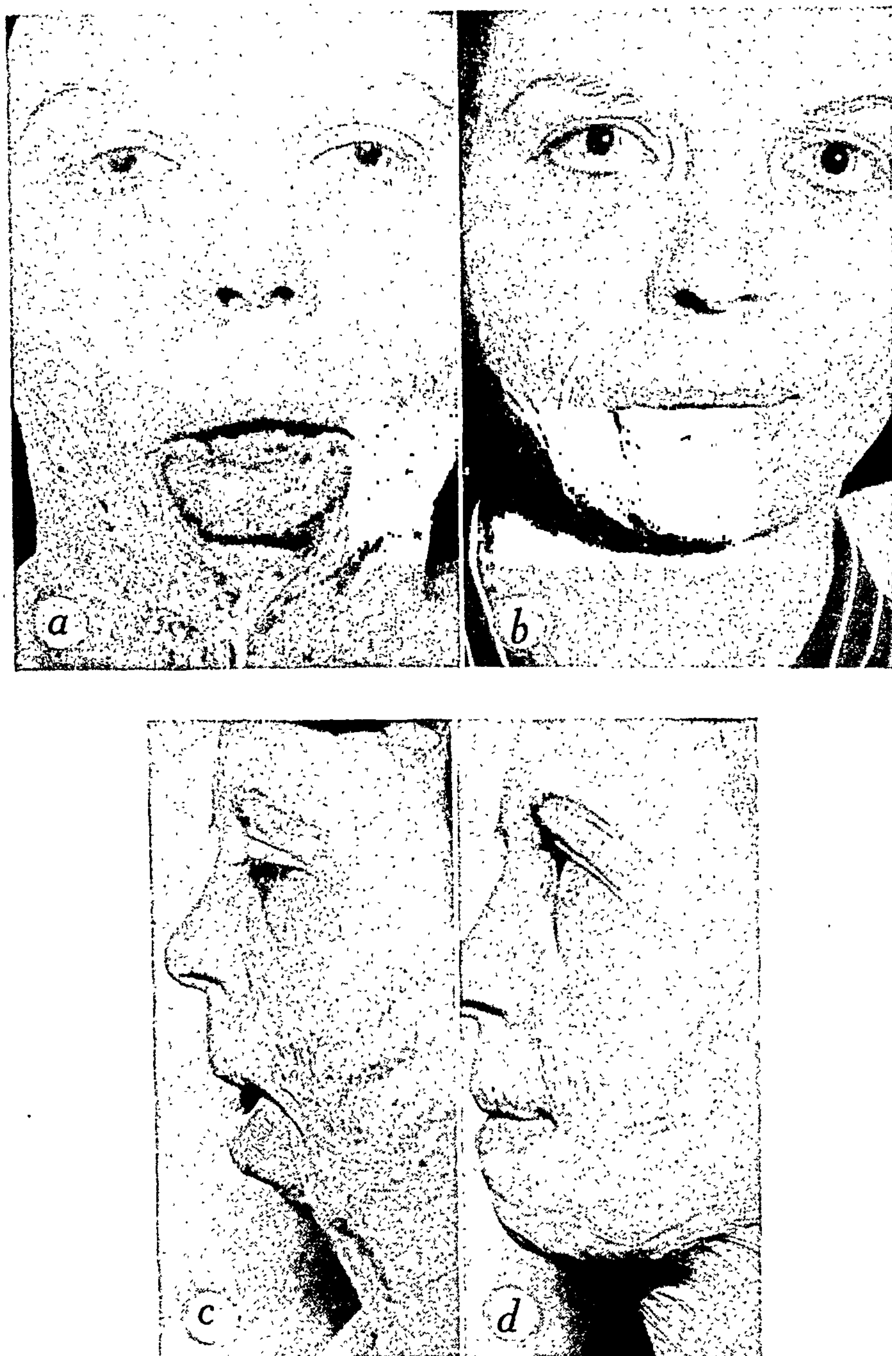


Fig. 68.—*a* and *c*, Total ectropion of the lower lip; partial fixation of the head; atrophy of the mental portion of the mandible; obliteration of the chin and neckline as the result of traction by scar; *b* and *d*, result following Z plastic operations on the neck; interpolated skin flaps on the lower lip; intra-oral excision of excessive mucosa; implantation of shaped cartilage and dermal grafts in the mental region; the patient has face powder on the skin in these final pictures.

Design *Z* flaps with the central member of the *Z* dividing the elevated scar in the midline of the neck from a point just below the chin to a point midway to the clavicle. The lateral arms of this *Z* are projected at angles of 60 degrees (p. 38). Dissect the included flaps, the scar, and the subcutaneous tissues surrounding the bases of these flaps. Transpose the flaps and stitch the approximating edges with interrupted sutures. The transposition of these flaps and the traction laterally partially reproduce the normal chin-neckline. Remove all sutures except those at the angles of the transposed flaps on the second day and support with strips of gauze applied with collodion.

Stage 3.—The interval between Stages 2 and 3 is six weeks.

Repeat the procedure described in Stage 2. Increase the lateral pull of the two flaps to correct further the neckline and to eliminate some of the scar tissues on the lateral borders and distal ends of the flaps (see "Multiple Excision," p. 42).

Stage 4.—The interval between Stages 3 and 4 is three weeks.

Make 1-inch (2.5-cm.) incisions, centering beneath each angle of the mouth, in the scar line beneath the mandible. Dissect the subcutaneous tissue of the chin and lip area between the two incisions. Carry the dissection to the buccal sulcus. Dissect a strip of skin 6 inches (about 15 cm.) long and 1 inch (2.5 cm.) wide from the abdomen. Remove its epithelium. Fold it on itself and draw it into the dissected tunnel (see "Dermal Graft," p. 23). Close the incision with interrupted sutures.

Stage 5.—The purpose of Stage 5 is to elevate the depressed angles of the mouth.

Follow the procedure described in the legend of Fig. 66 or the reverse of the procedure in Fig. 65.

MICROSTOMA

The buccal orifice—the mouth—may be reduced and fixed (Fig. 69) by scarring and contraction following severe burns, ulcerations of the skin and muscle, and by traumatic loss of the tissues external to the mucosa. The labial and buccal mucosa may be involved to the extent of fixing the lips and limiting motion of the jaw.

In the presence of the conditions mentioned in the first sentence of the preceding paragraph, the defect and loss of function can be corrected with the tissue present. In the presence of the conditions mentioned in the second sentence, it is necessary to remove the scar bands and adhesions and to add new epithelial tissue. This can be

accomplished, after opening the mouth, by following Waldron's application of Esser's technic for epithelial inlay.

Esser-Waldron Method

In effecting the latter of the procedures just mentioned, the scar bands are incised and released in the buccal sulcus. The borders of the raw surfaces are undercut, and a mold of dental modeling compound is fitted into the resultant cavity. This is covered with a thick Thiersch graft applied with the raw surface outward. The margins of the wound are sutured, and the mold is left in place for eight to ten days. The mold is then removed, the new skin surface dried in the air, and the mold replaced. This procedure is repeated daily until organization and contraction are complete. The mouth may then be repaired.

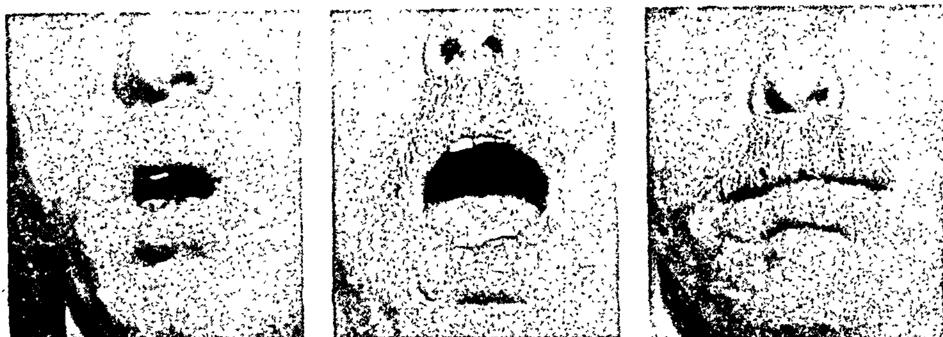


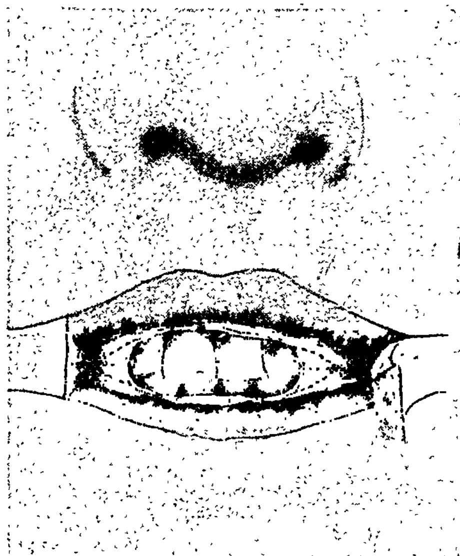
Fig. 69.—Microstoma resulting from chemical burn. *Left,* maximal oral opening before reconstruction; dense scar replacing the mucosal borders of the lips and the normal tissues about the angles of the mouth; *middle* and *right,* result of reconstruction.

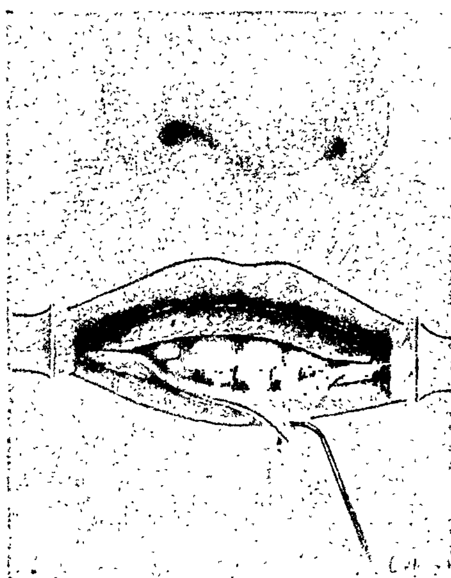
Werneck Method

A modification of Werneck's operation to utilize small turned-in skin flaps at the commissures produces a satisfactory result.

The size and shape of the mouth desired is outlined on the skin and the incision carried through skin and muscle and scar, or through skin and scar, to the mucosa (Fig. 70, *upper*). The distance between the commissures is exaggerated to allow for subsequent contraction. This is further prevented by folding in skin tabs (Fig. 70, *upper* and *lower right*) at the angles and suturing these to the buccal mucosa. The immediate effect is a square commissure. This subsequently is molded by traction of the scar into an acceptable angle. The skin can be replaced by mucosa later if it is desirable. The mucosa is







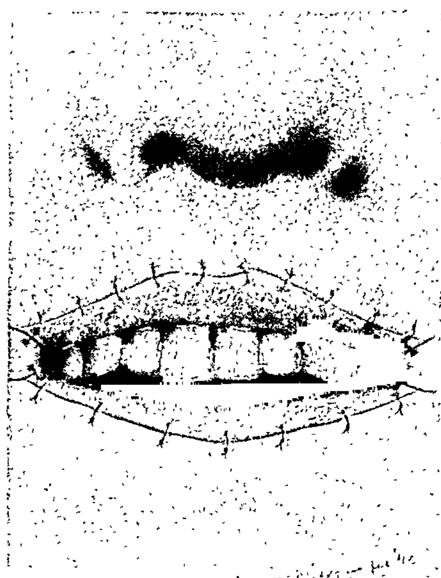


Fig. 70.—Microstoma. *Upper,* the incision in the skin is carried through the soft parts to the buccal mucosa, and the skin tabs are outlined; *lower left,* the mucosa is freely undercut and trimmed to cover margins of lips; *lower right,* the mucosa is sutured to the cutaneous margins with horsehair. The skin tabs are folded and sutured to the buccal mucosa.

trimmed to fit the margins of the lip and is sutured in place with horsehair (Fig. 70).

ABBÉ OPERATION

Indications

Narrow, tight upper lip; short upper lip with a full lower lip, or a reversed situation.

Requirement

Addition of all elements of the lip: skin, supporting tissues, mucous membrane.

Procedure

Stage 1.—Make a median, vertical incision from the base of the columella downward through the free margin of the lip (Fig. 71, *e*). Remove all scar. The released halves of the lip immediately assume

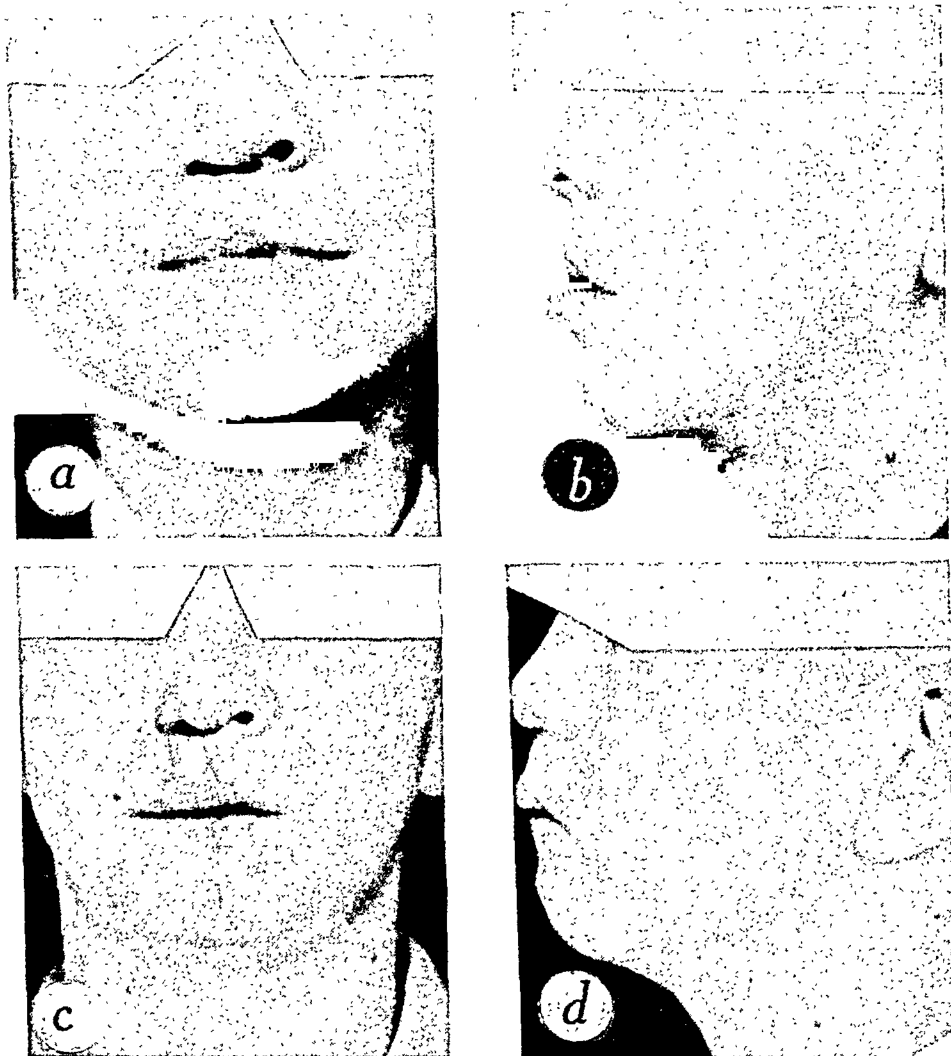


Fig. 71.—Estlander-Abbé operation. *a*, Distortion of the ala, tip of the nose, and mucocutaneous border of the lip; *b*, note the tension of the upper lip and the inequality of tissues of the two lips; *c*, appearance of patient after transposition and organization of a flap from the lower lip; *d*, appearance of the upper lip after reconstruction; compare with *b* (V. H. Kazanjian).

their proper lateral locations and define the borders of the triangular defect to be repaired (Fig. 71, *f*).

The construction of a balanced mouth requires a careful appraisal of the proportions of the lower lip. It is advisable frequently to supply

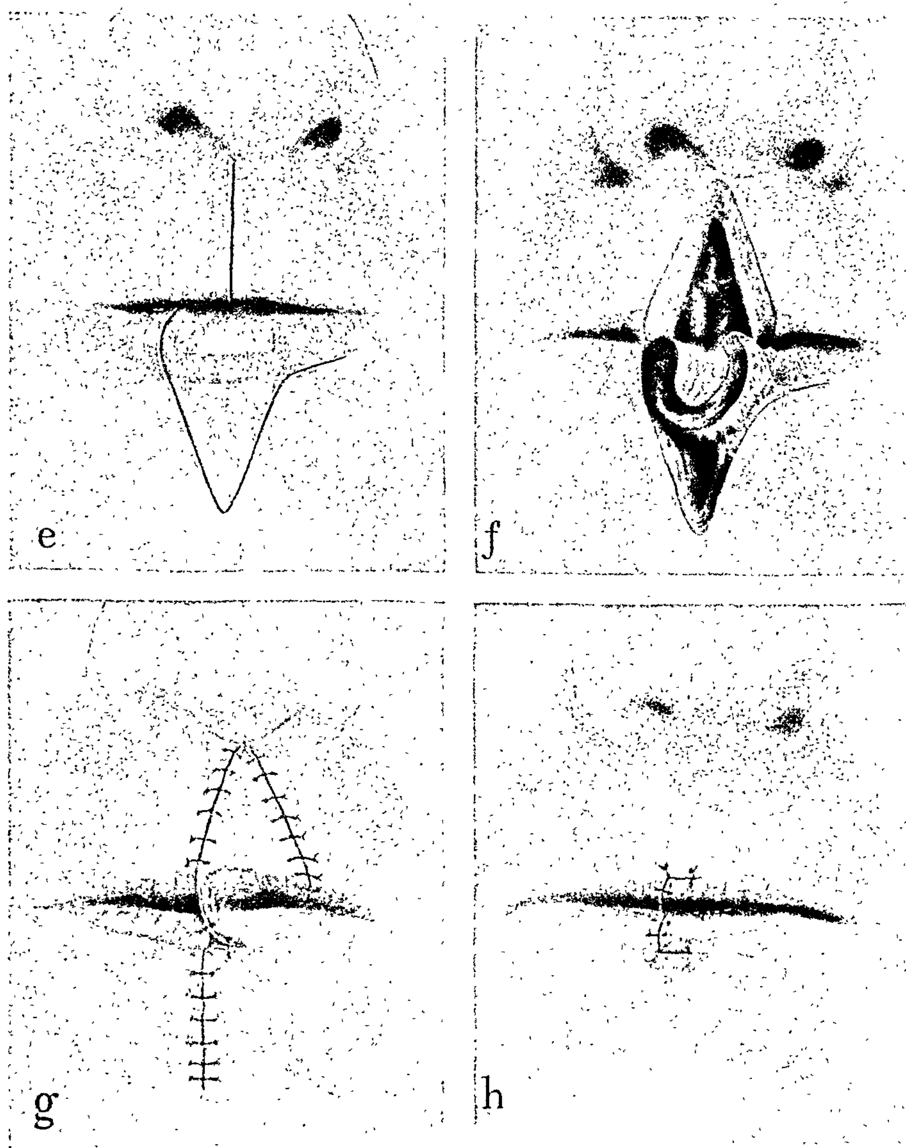


Fig. 71.—Estlander-Abbé operation in diagram. *e*, The lines of the incisions through the full thickness of the upper and lower lips; *f*, the appearance of the upper lip after section; lower lip flap partially excised; *g*, flap of lower lip sutured into the upper lip; pedicle attached; *h*, excision of the pedicle of flap and adjustment of mucosal borders of lips.

half of the upper defect only from the lower lip in order to maintain balance of the mouth.

The measurement of the base of the wedge to be supplied from the lower lip having been determined, outline this with its base on the

free mucosal border of the lip and its apex in the midline. Outline a pedicle to contain branches of the labial artery and to consist of the



Fig. 72.—Estlander-Abbé operation. *a*, Two epitheliomas of the lower lip; excision; *b*, condition after rotating a wedge-shaped pedicle flap from the upper lip into the defect resulting from the excision; the pedicle between the two lips has not been cut; c, condition after division of pedicle; *d*, profile of the completed result (Webster).

full thickness of the vermilion border of the lip on its left side (Fig. 71, *e*). Incise and rotate this wedge and pedicle. Relax and

The construction of a balanced mouth requires a careful appraisal of the proportions of the lower lip. It is advisable frequently to supply

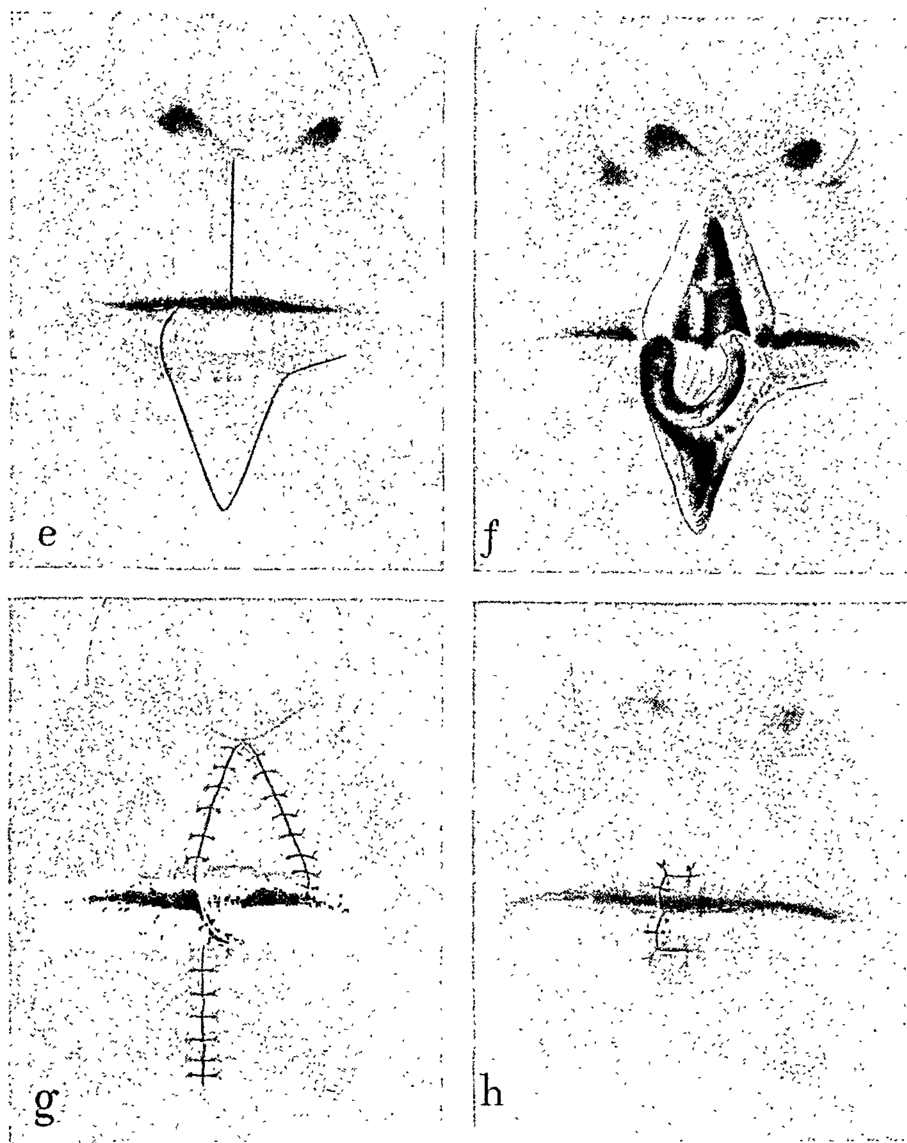


Fig. 71.—Estlander-Abbé operation in diagram. *e*, The lines of the incisions through the full thickness of the upper and lower lips; *f*, the appearance of the upper lip after section; lower lip flap partially excised; *g*, flap of lower lip sutured into the upper lip; pedicle attached; *h*, excision of the pedicle of flap and adjustment of mucosal borders of lips.

half of the upper defect only from the lower lip in order to maintain balance of the mouth.

The measurement of the base of the wedge to be supplied from the lower lip having been determined, outline this with its base on the

the adjacent muscle; loss of skin of the left half of the upper lip; and a torn parotid duct (Stensen's). Subsequently osteomyelitis of the entire mandible developed.

The soft parts presented the condition noted in Fig. 73, *left*, three months after injury. The old scar of the lip was incised to free a flap (A in Fig. 73). Incision was carried about the left ala of the nose and upward for a short distance in the nasofacial groove. The incision was carried laterally, intra-orally, in the scar covering the loss of the alveolar process to free further the lip and cheek flap. An incision was made along the borders of the depressed adherent scar of the cheek,



Fig. 73.—Partial loss of border of lip. *Left*, loss of mucocutaneous border, adjacent full thickness of substance of the lip, and a part of the musculature of the midportion of the lip from a gunshot wound; *right*, result of the procedure described, together with the significance of letters, in the text.

and the adjoining skin was freely undercut. The epithelial surface of the scar was removed, and the skin, with its underlying fat, was approximated over this scar base (Fig. 31; see also Fig. 80).

The vermilion border of the normal segment was incised from the angle of the mouth to the edge of the defect. The mucosa was freely undercut and the muscle incised on the free border of this segment to receive the end of the point of the prepared flap (Fig. 73, B, C). This approximation brought the free flap to its proper level. The mucosa of the normal segment was advanced laterally to its limit and approximated to mucosa of the flap, which had been undercut and advanced to the cutaneous margin.

approximate the mucosa and muscle of the defect in the lower lip with vertical mattress sutures of silk. Approximate the skin with interrupted sutures of horsehair (Fig. 71, *g*). Rotate the excised wedge into the defect of the upper lip and approximate in a similar manner.

Paint the intra-oral suture lines with compound tincture of benzoin and cover the skin suture lines with gauze moistened with alcohol. Apply a Barton bandage and maintain it in place for ten days to two weeks. Feed the patient through either a nasal tube or, in the event of missing teeth, a tube intra-orally.

Stage 2.—This stage is performed after a minimal interval of two weeks has elapsed since Stage 1.

Amputate the pedicle from the border of the lower lip so as to allow adequate mucosa for completion of the repair of both lips. Make the necessary adjustments and suture the borders with horsehair.

PARTIAL LOSS OF BORDER OF LIP

Small partial losses of the border and substance of the lips can be repaired readily, without introduction of new tissue. The result can be accomplished usually by readjustments. This applies particularly to notches in the mucosal border and somewhat greater losses of substance. The principles pertaining to sliding and rotated flaps usually meet the requirements with proper planning (p. 15).

Vermilion Border

This can be obtained in several ways, depending on the extent of loss: (1) The mucosal lining of the adjusted portion of the lip can be advanced by undercutting and sliding. (2) The vermilion border of the normal portion of the lip can be incised along the mucocutaneous line and freely undercut. This can then be advanced from ⅜ to ½ inch (about 1 to 1.3 cm.), depending on the length of this residual portion. (3) A flap can be rotated from the bordering cheek. It is usually necessary to elevate and delay such a flap until its blood supply has become assured. (4) A tubed flap can be prepared from the buccal mucosa and rotated to attach to an end of the defect, after which the tube can be opened and utilized for the repair.

The patient pictured in Fig. 73 illustrates some of the methods discussed. The loss in this instance resulted from gunshot wound. There were multiple fractures of the mandible; loss of bone from the left horizontal ramus; loss of the entire left alveolar and palatal processes; loss of full thickness of the cheek from the angle of the jaw to the middle of the mouth; loss of the vermilion border and much of

STAGE 2.—Outline and incise the flaps as planned (Fig. 74). Free the base of flap A. Dissect flap B free from its underlying attachments and freely undercut its base. Suture the upper distal edge of flap A to the angle of the mouth at point C. Elevate flap B and suture it to the inferior border of flap A. Close the defect in the neck produced by elevating flap B by undercutting the surrounding skin and sliding it, to suture to the inferior margin of flap B. Paint the intra-oral suture lines with compound tincture of benzoin. Dress the suture lines on the lip with gauze moistened with alcohol. Remove the skin sutures in forty-eight hours and support with gauze collodion strips.

STAGE 3.—The mucous membrane for construction of a vermilion border for the lower lip is obtained from the upper lip.

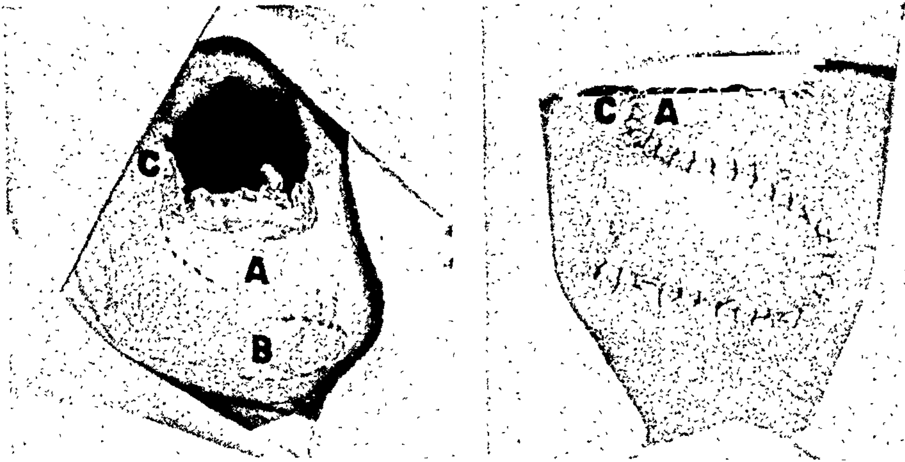


Fig. 74.—Weber operation (cadaver demonstration). *Left,* total loss of lower lip. Outline of flaps on the chin and neck for the reconstruction; *right,* flaps transposed to repair the defect. Letters on face of illustration are explained in the text (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

Carry an incision through the mucosa from angle to angle of the upper lip along a line about opposite the mucocutaneous line on the anterior surface of the lip. Make a short, vertical incision at each end of this horizontal one. Dissect the flap thus outlined free from the underlying muscle and suture its edge to the freshened superior border of the lining flap of the lower lip. This suture line may be complete, across the entire border of the lip, or a small portion at one angle may be delayed to permit feeding the patient through a tube at this point. In either event, suture the lips together or apply a Barton bandage firmly and leave it in place for ten days.

STAGE 4.—An interval of ten to fifteen days is allowed to elapse between Stages 3 and 4.

LARGE PARTIAL AND TOTAL LOSS OF LIP

Planning Procedure

Any plan for the reconstruction of a large partial or total loss of either the upper or lower lip should include, and be limited to, those procedures which conserve all of the muscular function present about the borders and improve the function. These rather than cosmetic considerations should govern the surgeon. The final *appearance,* however, should have all of the consideration which it merits so far as is compatible with improvement in function.

It has been pointed out on page 7 that few, if any, of the operations commonly described in texts for large partial or total reconstruction of the lip should be employed. The best *functional and cosmetic result* can be obtained by limiting the plan to one of a few procedures. It has been the author's experience that the procedure described on page 106 and illustrated in Fig. 75 is the operation of choice when the condition of the bordering tissues permits its employment. *It is never necessary to cut into the musculature about the defect to effect repair.* An entire lip, either upper or lower, can be lined and covered from the immediate vicinity of the defect with a minimum of scar, or the tissue can be brought in from a distance. The operation of Weber for the repair of a lower lip is sometimes useful and occasionally yields a good functional and cosmetic result. It contemplates the use of flaps from beneath and from each side of the defect which are "laced," or alternately placed, one above the other.

Weber Operation for Large Partial or Total Loss of Lip

Loss.—All or a large part of the entire substance of the lower lip.

Requirements.—Covering, supporting, and lining tissue; vermilion border.

Procedure. STAGE 1.—The posterior surface of a flap (A in Fig. 74) will be exposed in the mouth and consequently will require an epithelial covering. This can be provided as follows:

Undercut the entire attached surface of the proposed flap. Make an impression with plastic, dental modeling compound of the cavity thus created. Cover the anterior surface of this model with split skin, raw surface outward, and insert it into the cavity. Apply a firm dressing and leave it in place for six to eight days. Remove the model at this time. Dry the new cutaneous surface on the flap, in the air, and replace the model. Repeat this procedure for several days until organization of the new graft is completed.

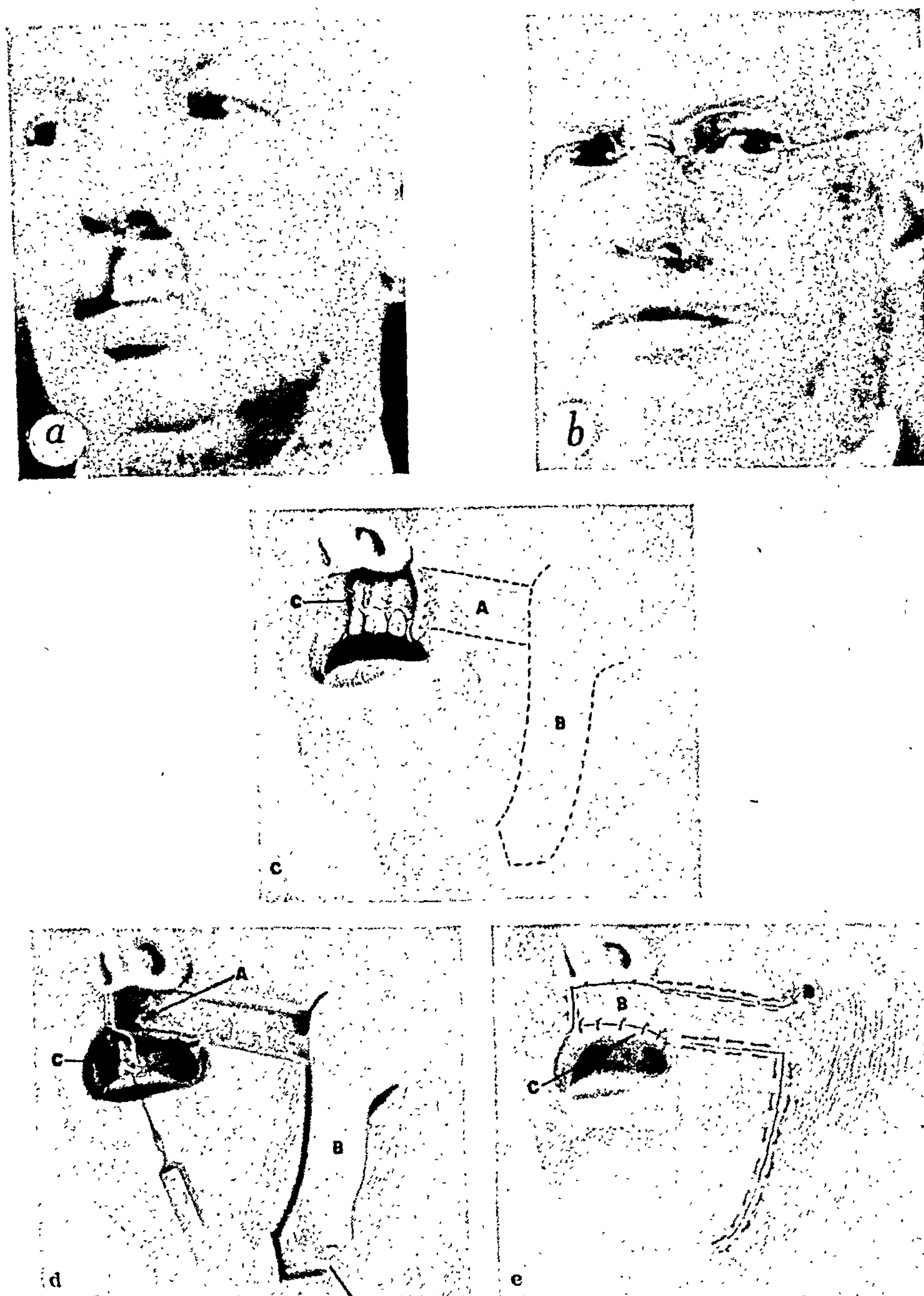


Fig. 75.—Subtotal loss of the upper lip. *a*, Patient before reconstruction; *b*, end-result; *c*, method of managing the skin and mucous membrane on the margins of the defect; outline of the lining flap, A, and covering flap, B, for the reconstruction; *d*, lining flap in situ, A; covering flap, B, and mucocutaneous margin flap, C, dissected; *e*, skin covering flap rotated and sutured in position, B; mucocutaneous border flap sutured in position, C; skin defect in face and neck closed and sutured; D is explained in the text, under Stage 4.

is undercut and accurately approximated to the mucosal remnant along the buccal sulcus. The suture lines are painted with compound

Dissect the mucous-membrane flap attached to the upper lip upward for a distance of $\frac{3}{8}$ inch (about 1 cm.) and free it by a horizontal incision parallel with the original one. Suture the free edge of the mucous-membrane flap thus obtained to the freshened superior border of the covering skin of the lower lip. Freely undercut the mucosa bordering the defect in the lining of the upper lip and close the defect with interrupted horsehair sutures.

Reconstruction with Skin Flaps for Large Partial and Total Loss of Lip

This reconstruction is completed in four stages, with proper intervening intervals of time (Smith's method).

Procedure. STAGE 1. COMPLETE DÉBRIDEMENT AND PREPARATION (IMMEDIATE).—The management of the borders of the defect must anticipate reconstruction of the lip. Flaps for a lining to replace the lost mucosa, for the outer skin covering and for the vermilion margin, must be so planned that ample material enjoying an adequate *blood supply* is available.

The blood supply of the *lining flap,* which will be reflected from the skin adjacent to the angle of the mouth, must come from the buccal mucosa and the muscle bordering the defect. Consequently, the mucosa on this edge must be undermined and accurately approximated to the skin with fine, closely placed horsehair sutures. This produces a minimum of scar and a maximal blood supply. This blood supply is usually adequate, but it can be guaranteed by outlining, partially undercutting, and again approximating this skin flap at this stage (Fig. 75, *c*, A).

The *covering flap* (Fig. 75, *c*, B) is outlined next. It can be raised and sutured in its original location at this time if the blood supply is questionable. The blood supply, however, is usually excellent.

It is sometimes advisable to utilize flaps from both sides of the mouth in the construction of an entire lip. When this method is followed, a long covering flap and a shorter lining flap should be cut on one side and the reverse procedure practiced on the opposite side. This will place the junction line of the covering flaps at a different place from that of the union of the lining flaps and will prevent a depressed, adherent scar line (Fig. 76, *e*).

The mucosa bordering the edge of the remnant of the lip is similarly undercut and sutured. This mucosa will be utilized to form the *vermilion border* of the reconstructed portion of the lip (Fig. 75, *c*, *d*, C).

The remaining skin bordering the defect—chin or face and nose—

a gauze dressing wet with alcohol. All stitches in skin are replaced on the second or third day with gauze collodion supports, which are maintained a minimum of ten days (p. 32).

Stage 4. Corrections.—The procedures are performed thirty to sixty days after Stage 3.

The teat, D (Fig. 75), created by rotation of the covering flap, B (Fig. 75, *d*, *e*), is adjusted by removal of excess skin and suture. This should not be done sooner than the twelfth day because of possible damage to the blood supply of the transplanted flap prior to this time. Any other cosmetic defects are corrected at this period.

The skin lining of the lip, which is formed by reflection of skin from the face, may be replaced by mucosa, if there is reason to do so, at any time after sixty days. This is effected by multiple excision. Approximately half the skin can be removed at the first stage and buccal mucosa advanced to fill the defect. Sufficient relaxation of the mucous membrane will again occur at the end of four to six weeks to permit further excision.

Fig. 76 is another example of loss of a lip which was repaired by flaps from adjacent tissues.

Losses So Extensive that Flaps from Adjacent Regions Cannot Be Used

Extensive losses of the lips, cheek, and other surrounding structures cannot be repaired from the neighboring tissues. The attempt to effect such repair would involve further destruction of function and produce greater cosmetic disability.

Source of Material.—The required tissues must be obtained from that portion of the body offering the best material and the most certain and comfortable conveyance with the least cosmetic disability. The *covering* and *lining* tissues are best supplied from the arm, when this is available (p. 18 and Figs. 7, 8, 9; see also Fig. 78). The tissue may be obtained from back, chest or abdomen if this is necessary.

Planning.—This must include consideration of the patient's comfort during the repair and the time involved, as well as the prime considerations noted above. The pedicle and flap which it conveys must be so planned that it will meet all of the requirements except that of supporting tissue. Flaps from the *forehead* and the *scalp* should be avoided unless they meet a particular requirement.

In cases of extensive loss of bone, prosthetic supports or scaffolding must be applied during the period of reconstruction of the soft tissues and later replaced by bone and cartilage, or both, together

tincture of benzoin until they have become thoroughly sealed. A strip of gauze is fastened with collodion to the cheeks on each side to limit movement. The wound in the cheek (outlined flaps) is covered with an alcohol dressing fixed with adhesive tape.

STAGE 2. PREPARATION OF LINING.—The purpose of this is to destroy hair follicles. The operation is performed three weeks after Stage 1.

Incise the superior and inferior borders of flap A (Fig. 75, c). Elevate the skin. Place a spatula under it. Shave the epithelium deep into the corium. Obtain hemostasis by sponge pressure. Cover the surface with a thick, split skin graft from the arm or leg. Fix with a basting stitch. Apply a layer of gauze permeated with scarlet red ointment, several layers of gauze, and firm pressure with adhesive strips; leave in place for six to eight days. Dress at intervals, subsequently, until the graft has become organized.

STAGE 3. RECONSTRUCTION.—This is performed two weeks following Stage 2.

The mucous membrane on the edge of the remnant of lip is removed between two parallel incisions placed 1 cm. apart. One incision is carried down its line of union with the skin and the other through the mucosa on the posterior surface of the lip. The blood supply of the remnant is provided by the mucosa on the free margin of the lip and a broad portion of mucosa posteriorly. Flap C, formed by the maneuvers just described, is held on a sharp hook; it will form the vermilion border of the reconstructed lip (Fig. 75, C).

The *skin flap* (A in Fig. 75), carrying underlying fat, is turned from the face on a "hinge" and sutured to the incised margin of the mucosa on the posterior surface of the remnant of lip and along the superior border of the defect.

The *covering flap,* B, is incised and elevated with the underlying fat (Fig. 75). The skin of the face on each side of the defect, resulting from elevation of the covering flap, B, is freely undercut and approximated with horsehair sutures. Approximation of these skin edges adds two-thirds of the width of the flap to its length. This covering flap, B (Fig. 75, *d, e*), is rotated 90 degrees to cover the lip and the defect left by reflection of the lining flap, A (Fig. 75). The opposing skin edges are sutured with horsehair.

The anterior edge of the *mucosal flap,* C (Fig. 75, *d, e*), is sutured to the free edge of the covering flap with horsehair. Its posterior edge is sutured to the lining flap.

The suture lines about the mouth are painted with compound tincture of benzoin, and those on the face and neck are covered with

The defect pictured in Fig. 77 results from loss of the full thickness of part of the lips and adjacent cheek. Loss of this extent constitutes a borderline case in the planning and choice of material. It may be repaired from the neighboring tissues without objectionable added cosmetic disability, or it may be repaired with tissues obtained and transported from a distance. All of the necessary tissue to replace the skin covering, the lost mucosal lining, and the supporting or filling tissue, can be furnished by a pedicle flap from the arm. The required mucosa for the vermilion border of the repaired defect is obtained from the upper lip or the buccal mucosa.

Procedure. STAGE 1.—Outline a flap of the desired width and length on the lateral surface of the arm, so that its base or pedicle is located on the shoulder. Incise the lateral borders of flap A to leave a lateral bridge of skin at points B and C (Fig. 77) and completely outline the distal portion, E. Elevate the distal portion of flap E and undercut the skin of the entire flap to point D.

Pass sutures armed with a needle on each end through the inferior margin of flap E and through the undersurface of the flap at point B. Draw the flap, E, under the main flap with the sutures and tie lightly. Suture the edge of the infolded flap to the edge of the covering flap along the incised line between B and C. Close all incisions with interrupted horsehair sutures.

STAGE 2.—A minimal interval of three weeks is allowed to elapse between Stages 1 and 2.

Again incise lines A. Undercut the skin and attached fat of the outlined flap. Control carefully all bleeding. Suture the raw edges of the flap to form a tube. Undercut freely the surrounding skin on the arm. Pass one or two strong relaxation sutures (Fig. 19) and approximate its edges with interrupted sutures of horsehair. Dress with fluff gauze so arranged as not to constrict the newly formed tubed pedicle and apply a moderately firm bandage.

STAGE 3.—An interval of three weeks is allowed to elapse between Stages 2 and 3.

Incise the bridges of skin at B and C (Fig. 77). The flap may be utilized if the blood supply in the distal, doubled flap F remains adequate on elevation and rotation of the pedicle. It is sutured again otherwise and allowed to remain on the arm for a subsequent period of ten days or two weeks. It is again elevated and rotated, at this time, to determine the adequacy of its blood supply. This process of "delay" is repeated until the blood supply is satisfactory.

The lining is split from the skin covering around the margins of the defect. The folded skin at the distal end of the flap is incised

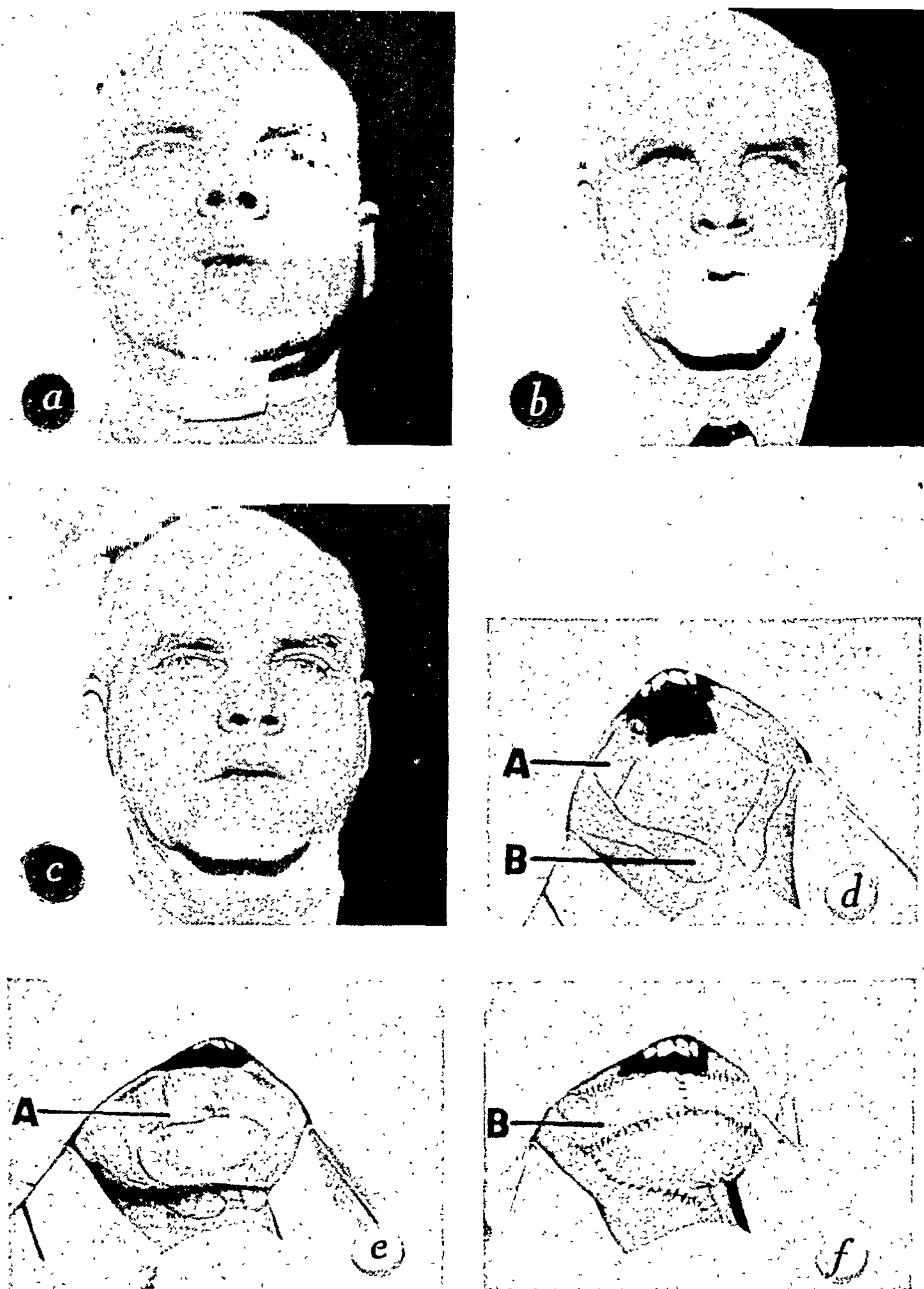


Fig. 76.—Reconstruction of the lower lip. *a*, Appearance two weeks after excision of lip and dissection of both digastric and submental triangles; *b*, muscular action of the reconstructed mouth; *c*, the reconstructed lip; *d*, outline of flaps; *e*, lining flaps, A, transposed; *f*, covering flaps, B, transposed; defect in skin of neck closed.

with such other supporting tissues as are necessary to obtain contour and so forth.

The head is rotated toward the shoulder, the shoulder elevated, and the flap swung into the defect (Fig. 81). The lining and skin of the flap are approximated to the borders of the defect with interrupted sutures. The arm and head are fixed with a plaster dressing to prevent damaging excursion (Fig. 8; see also Fig. 168).

STAGE 4.—The interval between Stages 3 and 4 is three weeks.

Excise the tube at the posterior border of the defect and adjust its base to the surrounding skin of the shoulder. Adjust the posterior portion of the flap and suture it to the tissues of the cheek.

Extensive Loss of Lip and Surrounding Structures

This case (Fig. 78) is introduced to indicate a procedure for the repair of extensive loss of the structures to be named.

Loss.—Total upper lip, except the vermilion border; adjacent cheek, eyelids, eyeball, part of naso-orbital wall; nasal lining, and nose.

Requirements.—Epithelial lining for the nasal cavity. Fat and skin for filling and covering of the orbit. Skin covering for the face. Lining, covering, and supporting substances for the lip. Lining, covering, and supporting tissues for the nose. All of these requirements, except the supporting tissues for the nose, are supplied by a properly planned tubed pedicle flap from the arm.

The entire reconstruction is planned, not only as to introduction of tissue but also as to stages of the procedure.

Procedure. STAGE 1.—A period of three to four weeks is required for preparation of the tubed pedicle flap on the arm (p. 18).

The shoulder is elevated and the forearm flexed 90 degrees; the head is rotated toward the shoulder and a plaster dressing applied to the head and arm to fix it. The plaster bandage about the head is fixed over a skull cap which permits very limited motion (Fig. 8; see also Fig. 168).

Dissect the fat from the skin of the distal end of the flap and suture it in the nose to replace lining and furnish the future abutment for the reconstructed nose. The remaining fat, attached to the distal flap, furnishes a filling for the orbit. Suture the margins of this flap into the orbital and bordering defects in the cheek.

It is well to support the tubed pedicle during the first days of this period with a sling attached to the plaster head cap. The disturbed circulation following rotation results in marked edema and increased weight for a few days. Care must be given that this supporting sling does not constrict the circulation.

STAGE 2.—The interval between Stages 1 and 2 is three to four weeks.

and the incision carried around its inferior border to separate the lining and the covering. The superior border of the rotated flap forms

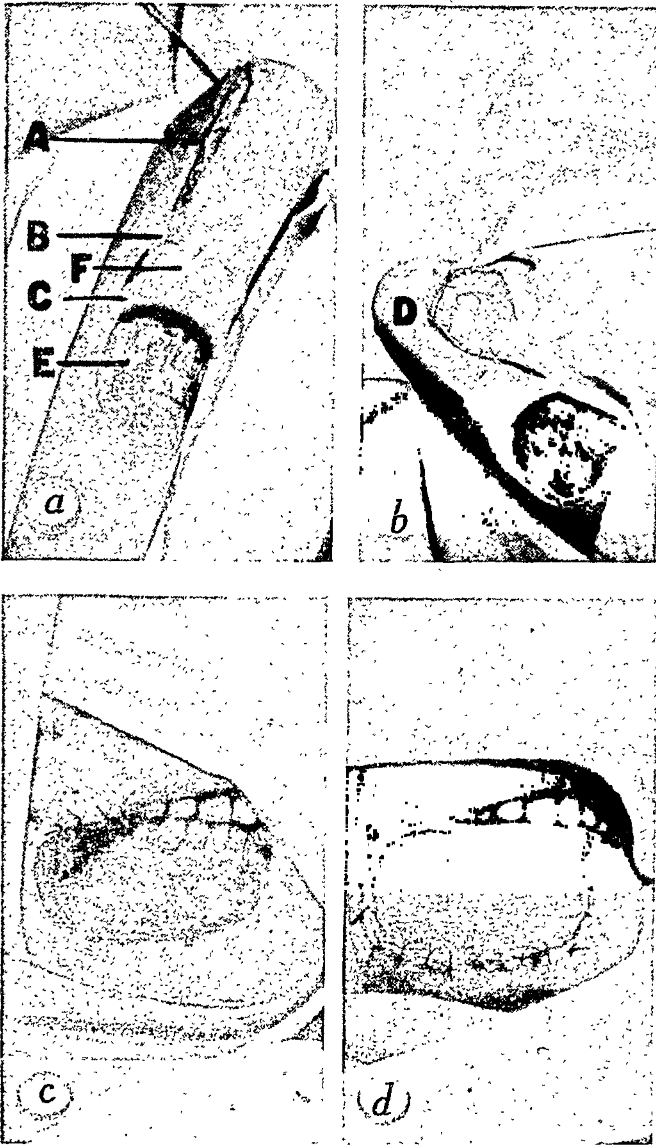


Fig. 77.—Cadaver demonstration. Partial loss of lip and adjacent cheek. a, Border incisions of a flap to form a tubed pedicle, A; flap folded to provide double epithelial surfaces, F; *b*, rectangular flap sutured to form a tubed pedicle, D; closure of the resultant skin defect; *c*, defect in the cheek and lip; *d*, tubed pedicle flap sutured in the defect; pedicle amputated. Letters on the face of the illustration to which reference is not made in the legend are accounted for in the text.

the free margin of the reconstructed lip. That portion of this margin which approximates the cheek is incised to separate the lining and covering layers.

Estimate the length of the tube required for repair of the defect in the cheek and lip and incise, partially, its sides at this point (Fig. 167). The incisions are extended after the lapse of three to four days, if no sizable vessel is encountered and the circulation is not visibly disturbed. This process is continued until the pedicle has been entirely severed.

Excise the scar line in the pedicle. Dissect the skin of that distal portion, which is to become the lip, sufficiently to permit its suture to the two surfaces of the remaining free border of the lip.

Approximate one skin edge of the pedicle to the skin of the facial defect, beginning at the superior portion of the pedicle, with interrupted horizontal mattress sutures of horsehair. The skin on the mesial side of this portion of the pedicle is ultimately removed to permit adhesion to the defect in the cheek. It must be retained until circulation of the lip has become adequately established (Fig. 78, B).

Split the superior margin of the remaining lip border and suture its posterior edge to the skin of the posterior aspect of the pedicled flap. Suture the skin margin of the anterior aspect of the pedicled flap to the edge of the external surface of the remaining lip border. Adjust and suture its distal end to the edges of the lining and covering of the cheek.

Incise and undermine the forehead flap for the nasal reconstruction along part of its superior border (Fig. 78, C). Introduce a full-thickness, or a thick intermediate, skin graft beneath the scalp and suture its edges to the flap incision to form the lining of the new nose.

Apply a gauze dressing and a firm bandage and allow it to remain for seven to twelve days, depending on the type of graft employed (p. 55).

STAGE 3.—An interval of three weeks is allowed to elapse between Stages 2 and 3.

Dissect the skin from that portion of the pedicle which approximates the cheek in the infra-orbital region and near the canine fossa. Retain all of the included fat. Suture the incised skin edge to the nasal lining. This edge (Fig. 78, *d* (D), *e*) will form the abutment for the reconstructed nose.

Open the scar line along the anterior surface of the lip, reduce the fat content of the flap, and again approximate the skin. Repeat this process at intervals until the lip presents the desired form and thickness (Fig. 78, E). Incise the entire border of the forehead flap for the nose (Fig. 78, *e*) and elevate, except at its pedicle attachment and at the point of entrance of the temporal artery into its distal end. Resuture in position.



Fig. 78.—Construction of a lip from a tubed pedicle flap. *a,* Loss of nose, lip, cheek, eyelids, orbital content, and partial loss of mesial wall of the orbit; *b,* tubed pedicle arm flap carrying fat for obliteration of orbit; flap has been folded into the nose to furnish a lining for its lateral half; the margins of the flap are sutured to the defect about the orbit, A; *c,* pedicle has been amputated; scar line of the tube has been opened and sutured to the bordering skin of the cheek and the residual vermilion margin of the lip; *d,* foundation abutment for nose completed; lip partially constructed; construction of a new nose on the forehead begun, C; *e,* the new nose, without cartilage support, sutured in position. Further reduction of fat in the constructed lip. *Inset,* completed construction of lip, E. Letters that appear on the face of the illustration but not in the legend are explained in the text (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

Estimate the length of the tube required for repair of the defect in the cheek and lip and incise, partially, its sides at this point (Fig. 167). The incisions are extended after the lapse of three to four days, if no sizable vessel is encountered and the circulation is not visibly disturbed. This process is continued until the pedicle has been entirely severed.

Excise the scar line in the pedicle. Dissect the skin of that distal portion, which is to become the lip, sufficiently to permit its suture to the two surfaces of the remaining free border of the lip.

Approximate one skin edge of the pedicle to the skin of the facial defect, beginning at the superior portion of the pedicle, with interrupted horizontal mattress sutures of horsehair. The skin on the mesial side of this portion of the pedicle is ultimately removed to permit adhesion to the defect in the cheek. It must be retained until circulation of the lip has become adequately established (Fig. 78, B).

Split the superior margin of the remaining lip border and suture its posterior edge to the skin of the posterior aspect of the pedicled flap. Suture the skin margin of the anterior aspect of the pedicled flap to the edge of the external surface of the remaining lip border. Adjust and suture its distal end to the edges of the lining and covering of the cheek.

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STAGE 4.—The interval between Stages 3 and 4 is three weeks.

Incise and elevate the nose flap. Form the tip and nostrils as described on page 165 (Fig. 108) and rotate the flap on its pedicle. This pedicle now includes the left anterior temporal, supra-orbital, and frontalis arteries. Split the lining skin from the covering along the inferior border of the flap and suture it to the skin and nasal lining of the left cheek and to the split edges of the superior margin of the new lip construction. Cover the scalp defect with a thick, split skin graft.

STAGE 5.—An interval of three weeks is allowed to elapse between Stages 4 and 5.

Split vertically the transplanted skin forming the right nasal lining and the covering of the right cheek and orbit and suture to the incised right edge of the reconstructed nose. Suture the lining skin with catgut and the covering skin with interrupted stitches of horsehair.

STAGE 6.—An interval of two weeks elapses between Stages 5 and 6.

Incise the nasal flap in the glabellar region, readjust its pedicle on the forehead and adjust the glabellar stump of the nose to its inferior margin. The cartilage or bone support may be introduced into the nose (Figs. 114, 115, *e*) as soon as thorough organization of these suture lines has occurred.

A prosthetic eye can be provided by the procedure described on page 217; see also Figs. 150, 241.

CHAPTER IV

MELOPLASTY

IN taking up reconstructive surgery of the cheek it is necessary to consider superficial losses of the skin and mucosa, losses involving



Fig. 79.—Muscles of expression and arteries. *1, 2, 3,* Heads of musculus quadratus labii superioris, respectively, as follows: angular head, infra-orbital head, zygomatic head; *4,* angular artery; *5,* musculus caninus; *6,* musculus orbicularis oris; *7,* musculus zygomaticus; *8,* musculus buccinator; *9,* musculus triangularis; *10,* facial artery; *11,* musculus quadratus labii inferioris (inferior labial artery); *12,* Stensen's duct (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

the skin and muscle only, and losses which involve all of the elements of the cheek. To this end, knowledge of the underlying muscles is essential (Fig. 79).

(See comment on "Undesirable Procedures," p. 7. Also see Section IV for "Anesthetic Technics.")

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subsequent addition of supporting material (dermal graft), if required. *Large losses* of the type are best repaired with a pedicle flap carrying a requisite amount of attached fat. This can be supplemented later with additional supporting material; for example, dermal graft and so on.

LOSSES OF FULL THICKNESS OF CHEEK

Losses of the entire thickness of the cheek which are too large for simple suture can be repaired by several useful and available combinations. *In all cases a proper epithelial lining of either mucosa or skin must be supplied.*

Operation for Small Defects

Small losses which are too large for the edges of the defects to be approximated and sutured without deformity can be repaired by suturing the bordering skin to the bordering mucosal lining of the defect in a manner to obtain the finest scar and the maximal blood supply at the point of union. This line of union will be utilized later as the base of a hinged flap of skin to repair the lining defect.

Procedure.—This is as follows: Shave the area of skin to be utilized as the lining flap with a skin-graft razor, cutting sufficiently deep to destroy the hair follicles, and cover it with a thick, split skin graft (Fig. 143). Elevate and delay this flap, after complete organization of the graft, until it enjoys an adequate blood supply. Split the mucosa from the skin around the margins of the defect, except at the line of its attachment of the mucosa to the prepared skin flap. Dissect and suture the skin flap to this mucosal edge of the defect (Fig. 75, *d*, A). Close the skin defect, whenever possible, with a carefully planned, sliding or rotated flap. This results in a covering skin of normal appearance. Such depression as results from loss of the intervening muscle and fat is subsequently corrected with dermal graft.

Pedicled Flap for Large Defects

A pedicled flap from a distance becomes a necessity if the defect is too large to permit utilization of the surrounding skin for closure. This flap can be employed in several manners: (1) It may be folded upon itself to provide skin on either surface, or its raw surface may be skin-grafted prior to its use. (2) The pedicled flap can be sutured to the defective mucosal border until an adequate new blood supply has been gained, and then the pedicled flap can be covered with a

LOSSES OF SKIN

Small defects can be repaired by sufficient undercutting and sliding of the bordering skin or by utilization of carefully planned, rotated flaps (Figs. 140, 141). Large defects can be covered with *thick, split skin,* or *full-thickness skin grafts,* or by the use of *pedicled flaps* from the vicinity or from a distance. Such repairs should be considered as temporary whenever the surrounding normal skin will permit ultimate removal of the transplant by multiple excision. (See also "Multiple Excision," p. 42.)

Superficial losses of *mucous membrane,* if not too large, can be repaired by sliding the bordering tissue, by the use of pedicled flaps rotated from the vicinity, or by the employment of Esser-Waldron inlay technic (Fig. 150).

Esser-Waldron Inlay

Esser's technic consists of dissecting out the scar, undermining the edges of the bordering tissue, making a mold of dental modeling compound to fit the defect, covering this with split skin, raw surface outward, and inserting and suturing this covered mold in the defect, to remain there for ten days. The edges of the mucosa are closed over the mold with horsehair sutures. A skin graft of this type will not control contraction of scarring (p. 56).

LARGE LOSS OF LINING

A large loss of mucosa demands different management. Skin must be introduced from a distance on a pedicled flap. This pedicled flap should be introduced through an incision which will leave the least deforming scar. Such an area would extend along the inferior margin of the mandible, from the crossing of the facial artery to the mental foramen.

The scar tissue is completely dissected, the mouth supported in "open bite," and the pedicled flap approximated to the borders of the defect with interrupted sutures.

The pedicle is amputated after three weeks and the edge of the flap adjusted in the cheek. The margins of the cutaneous opening along the jaw are pared and the skin closed with interrupted sutures.

LOSSES OF SKIN AND MUSCLE ONLY

Small losses of this type can be repaired in a manner similar to small losses of the skin, with added shifting of underlying fat and the

Amputate the pedicle of the flap and adjust the cut margin of the flap and facial skin covering. If the facial skin is involved in the contracture, it can be repaired by utilizing skin from the pedicle of the lining flap at this stage.

RETRACTED ADHERENT SCAR: CONTRACTURE OF ORAL OPENING

The condition illustrated in Fig. 80 followed compound comminuted fracture of the maxilla and the right malar bone, with subsequent infection and late reduction of fractures.

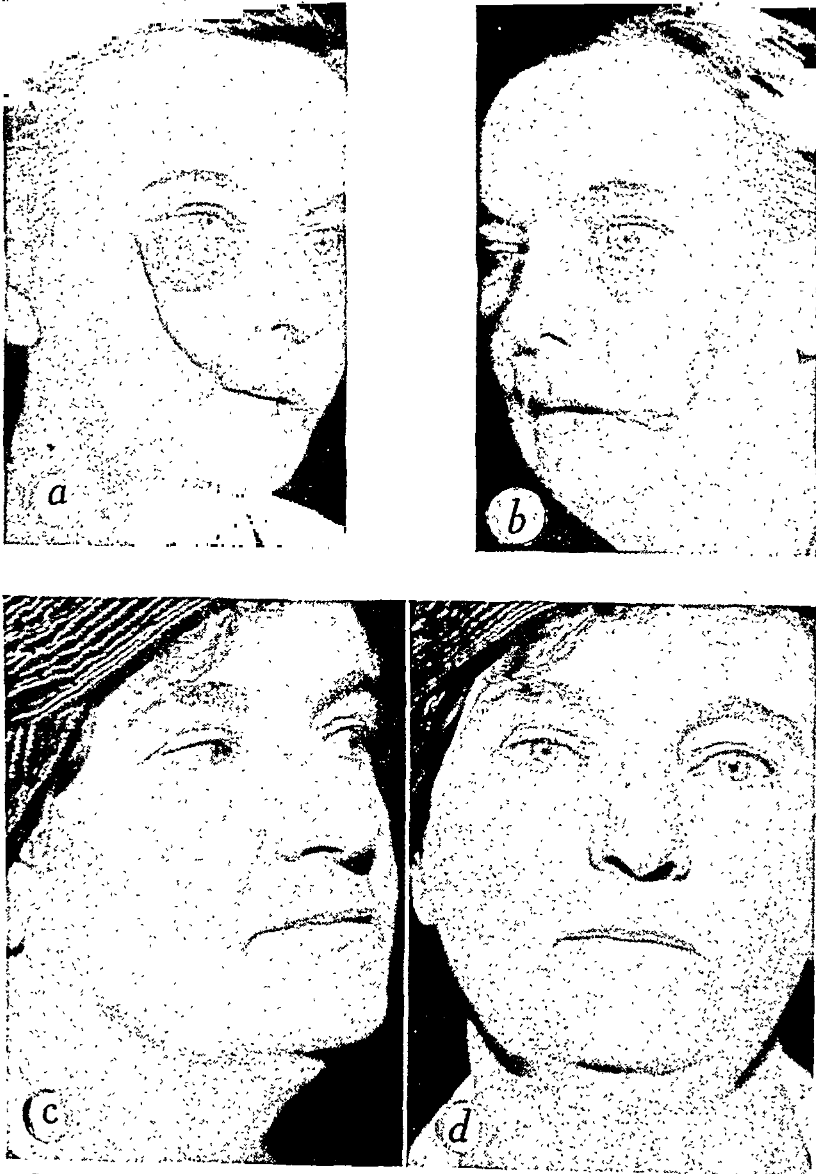


Fig. 80.—Poulard's operation (p. 35). *a* and *b*, Contracted, adherent scars of the cheeks; contracture of oral opening; c and *d*, appearance after repair.

portion of the pedicle, which is folded over the implanted lining. (3) A pedicled flap may replace the entire muscle and lining of the cheek and can be covered by the skin from the cheek.

The introduced skin rarely matches the normal surrounding skin. It may be removed, after thorough organization, by multiple excision (p. 42). It is frequently possible to supply the covering by free grafting. These grafts merit the same criticism as the pedicled flap and can be treated subsequently in a similar manner.

CICATRICIAL CONTRACTION

Restoration of Function

Contraction caused by scar of any or all of the elements of the cheek or muscles attached to the mandible may produce limitation of motion varying from slight disability to complete fixation.

Waldron's application of Esser's technic produces satisfactory results in those cases wherein the limitation of motion is moderate and depends on scar in the mucosa and underlying muscle (p. 56). New tissue from a distance must be introduced in cases wherein the destruction has been more widespread. There is considerable muscular atrophy from disuse, if the fixation is of long duration.

The management should be so planned that the nerve supply and remaining musculature are preserved in order to restore function, together with that of the mandible. The following procedure is employed:

Procedure. STAGE 1.—Incise the skin from a point 1 inch (2.5 cm.) above the angle of the jaw down to the margin of the mandible, along the inferior margin of the mandible to the mental symphysis, and curve the incision upward to divide the lower lip. Dissect the skin and underlying fat upward for 1 inch or more above the margin of the jaw.

Incise the buccinator muscle and scarred mucosa along a line parallel to and about ½ inch (about 1.3 cm.) above its attachment to the jaw. Dissect out any retaining scar. Avoid injury to the middle and lower branches of the facial nerve and to Stensen's duct. The muscle and scar remaining attached to the mandible provide an abutment for the reparative flap which is to be introduced. Fix the jaw in "open bite." Suture the free distal margins of the pedicled flap from the arm to the incised muscle and lining borders. Suture the elevated skin flap over the raw surface of the introduced pedicled flap (Fig. 81).

STAGE 2.—An interval of three weeks is allowed to elapse between Stages 1 and 2.

available fat. Approximate its free margins to the borders of the defect with interrupted sutures.

Approximate the skin flap, A, to the raw surface of the pedicled

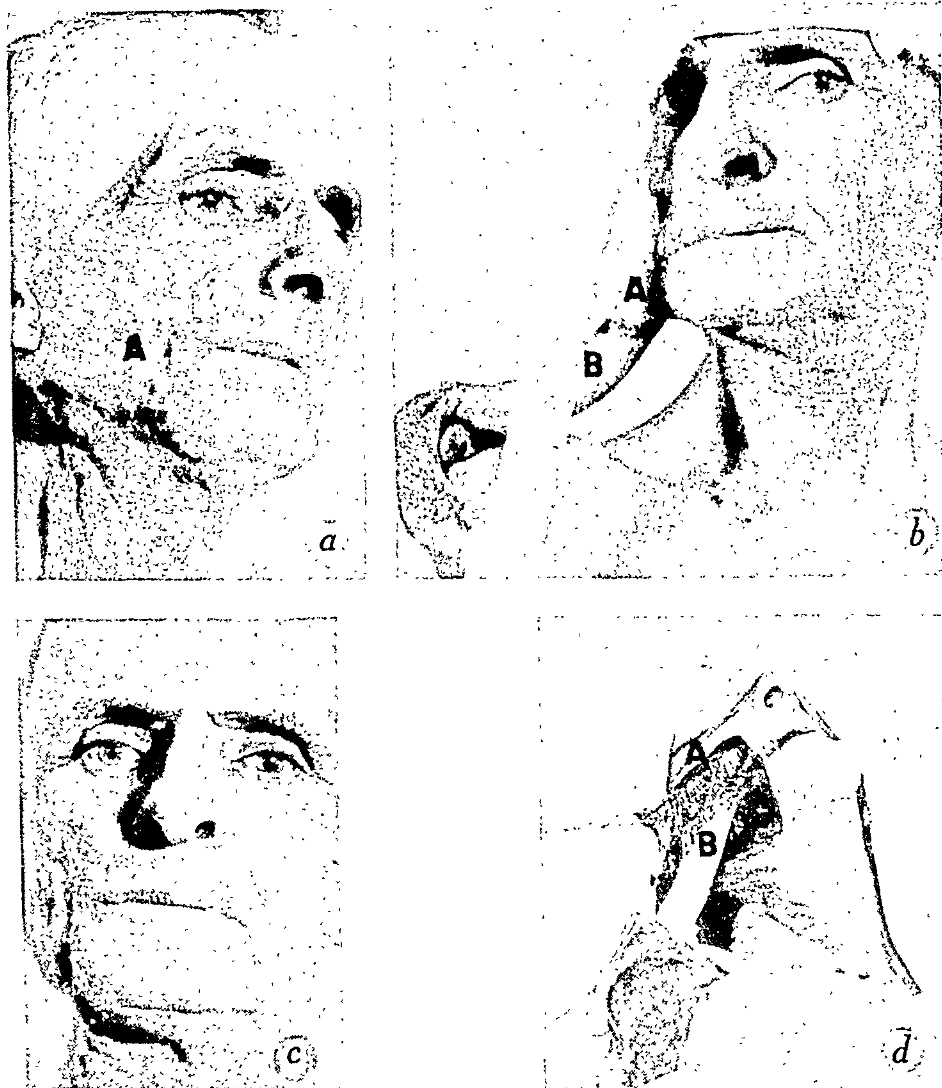


Fig. 81.—Loss of lining and musculature of cheek. *a* and *c*, Appearance of patient after reconstruction of the mucous-membrane lining and musculature of the cheek; *b*, tubed pedicle from the arm, carrying a skin flap and fat for the repair; fixation of head and shoulder with a plaster dressing; *d*, tubed pedicle flap, B; skin flap from cheek, A (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

flap, B, and stitch its margins to the margins of the defect in the cheek, with interrupted sutures.

Stage 2.—A period of three weeks intervenes between Stages 1 and 2.

Disability

The skin and musculature of the face are adherent to the periosteal covering, producing a retracted, fixed scar as a result of improper primary repair.

Requirements

Readjustment, without introduction of new tissue.

Procedure

There are several procedures for correction of this type of disability (p. 33). The procedure of choice is as follows:

Incise about the borders of the scar at right angles to the surface of the skin with a sharp knife and undercut the bordering skin (Fig. 31). Pare the epithelial surface from the scar, leaving its bed undisturbed. Slide the bordering skin over this remaining scar bed and approximate with horizontal mattress sutures. Apply a dressing of gauze moistened with 70 per cent alcohol. Remove the sutures on the second day and support with gauze strips applied with collodion.

The skin can be approximated with a subcuticular stitch which is either absorbable or of material which is removed at the end of ten to twelve days. In either event, the new line of union must be supported until its organization and softening are complete.

Other methods of dealing with contracted scar are detailed on page 34.

LOSS OF MUSCLE AND LINING

The circumstances in one case are represented in Fig. 81.

Requirements

New epithelial lining to replace the entire mucosa of the cheek, from the superior fornix to the mandible, and soft supporting tissue to replace the loss of muscle for cosmetic appearance.

Procedure

Stage 1.—Make an incision from the angle of the jaw along the line of the mandible to the region of the mental foramen and upward to a point just lateral to the angle of the mouth. Dissect all scar and involved tissue.

Elevate *and rotate a previously prepared pedicled flap* (B *in* Fig. 81) on the arm to present its skin surface mesially and its raw surface externally (Fig. 81, *d*). This flap carries with it all of the

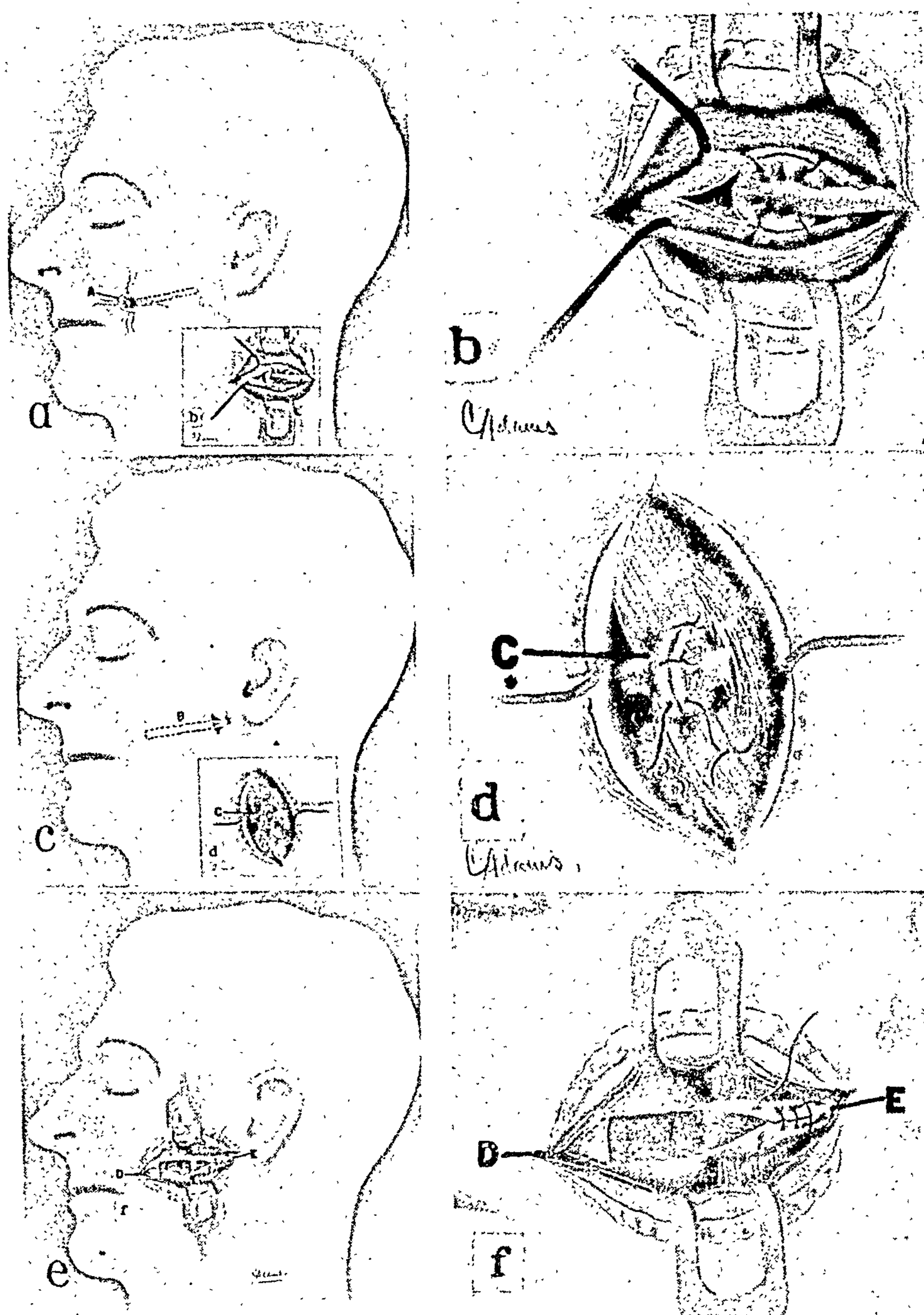


Fig. 82.—Salivary fistula in the cheek. *a* and *b*, Smith's modification of von Langenbeck operation; *c* and *d*, fistula over masseter muscle or at its border (Smith's operation); *e* and *f*, fistula between border of gland and edge of masseter muscle (Braun's operation). Letters which appear on the face of the drawing are explained in the text.

rupted sutures of fine silk and approximate the end of the flap to the free end of the duct (Fig. 82, e, *f*). The E in Fig. 82, e, *f*, represents the stump of Stensen's duct. Close the incision in the skin with

Amputate the pedicle, B. Dissect the skin covering, A, free from the margins of the lining flap. Adjust the incised edge of the flap to the lining defect. Pare the margin of the skin covering, A, and approximate it to the edge of the defect in the cheek with interrupted sutures. Apply a gauze dressing saturated with alcohol. Adjust the base of the pedicle, B, on the shoulder and approximate it with interrupted sutures.

SALIVARY FISTULA (FISTULA OF STENSEN'S DUCT)

The method of management depends on the location of the fistula.

Fistulous Opening ½ to ¾ Inch (about 1.3 to 2 cm.) Anterior to Anterior Border of Masseter Muscle (Fig. 82, *a*, A)

This fistula can be repaired readily by following a modification of von Langenbeck's technic. He passed a probe into the duct through the fistula and dissected the duct free from its surroundings. The duct was then drawn through a bluntly dissected tract in the buccinator muscle and sutured to the buccal mucosa.

Procedure.—It is somewhat easier and considerably more certain to raise a *disk of skin* about ⅜ inch (about 1 cm.) in diameter, about the fistulous opening and dissect this free with the attached duct (Fig. 82, *a*, A). Four horsehair sutures armed with a curved needle on each end are passed through quadrants of this disk of skin. These are used to draw the disk through a bluntly dissected tract in the buccinator muscle and buccal mucosa. The stitches are passed through the mucosa to approximate it to the margins of the disk. The circular defect in the skin is elongated by removal of a triangular piece at the opposite ends of its horizontal diameter, the surrounding skin is undercut, and the skin is approximated with interrupted horsehair sutures.

Fistulous Opening at Anterior Edge of Parotid Gland or Between It and Anterior Margin of Masseter Muscle

This can be repaired satisfactorily by either of two procedures:

Braun's Operation.—Incise the skin and superficial fascia from a point just posterior to the fistulous opening to a point about ¾ inch (about 2 cm.) anterior to the border of the masseter muscle. Reflect these flaps from the muscle. Incise a mucous-membrane flap of the desired length and width with its base at the margin of the masseter muscle (Fig. 82, *e*, *f*, D). Separate the fibers of the buccinator muscle just anterior to the masseter muscle and draw the mucous-membrane flap through it. Approximate the raw edges of the flap with inter-

latter two occurrences is identical, but the reaction of the nerve to injury and infection in the two locations differs materially.

The reaction to compression, injury to the sheath or to the sheath and some of the neurons is cellular and vascular in character and constitutes a vicious circle. The process is more rapid within the confines of a bony passage (canal or foramen).

The first evidence of weakness in muscular tone or action calls for investigation. Test the response to faradic current. Definite evidence of decrease in this response is indication for investigation of the site of injury. *Make this test daily* until the issue is settled. Remember that faradic current acts through the nerve only.

The *immediate management* in those cases in which there is section or loss of nerve substance depends on the general condition of the casualty. It is desirable, but may not be expedient, to effect immediate repair.

Remember that response to faradic stimulation is lost in the distal segment of the nerve in forty-eight hours after section. The presence of this reaction is a great aid in locating and following the nerve. The nerve is located by dissection only after loss of this reaction.

Surrounding Infection.—A nerve with an unbroken sheath resists pus for long periods. Treatment is as follows: Drain and clean up the infection. Slit the nerve sheath freely proximal and distal to the lesion. Dress open with saline solution. *Do not use antiseptic substances* at this stage.

Refrigeration or Toxemia (Bell's Palsy).—In approximately 80 per cent of these cases function is recovered without any interference. In cases in which recovery occurs, the response to faradic current never is lost. In the other cases (20 per cent), this response is lost within a few days. If improvement does not appear in three to four weeks, operation should be performed. Measures are as follows:

Prepare scrupulously. Irrigate the ear canal with hydrogen peroxide. Dry. Paint with 3 per cent iodine and remove with alcohol. Employ the usual external preparation. Proceed as below ("Injury without Loss of Substance") in a clean case.

Injury without Loss of Substance.—Decrease or loss of faradic response is one manifestation. Such injury may result from compression and crushing and from the neighboring passage of high-velocity missiles.

INJURY TO NERVE IN BONY PASSAGE (CANAL OR FORAMEN).—This procedure requires a competent otologic or neurologic surgeon. The nerve may be further injured during exposure by an inexperienced surgeon.

interrupted sutures of horsehair. Undercut the edges of the defect in the buccal mucosa and approximate with interrupted sutures.

Smith's Method.—The purpose of this method is to create an epithelial lined tract through the buccinator muscle and buccal mucosa and to connect this tract with a fistulous opening.

STAGE 1.—Make a vertical incision ⅝ inch (about 1.6 cm.) long just anterior to the fistulous opening. Dissect bluntly a tract beneath the skin to the edge of the masseter muscle and through the buccinator muscle *to the mucosa* at the normal outlet of the duct. Insert a glass rod, ¼ inch (about 0.6 cm.) in diameter and with rounded ends, covered with thick, split skin, raw surface outward. This skin is best applied by folding a long, narrow strip over the end of the rod and approximating the edges of the strip with a few fine silk sutures to form a sac (Fig. 82, *c*, B). Close the skin incision with two or three interrupted sutures. Apply a gauze pad with adhesive tape over the area.

STAGE 2.—This stage is performed ten days after performance of Stage 1.

Incise the buccal mucosa over the end of the glass rod. Reopen the skin incision and remove the rod. Replace it with a second rod which is longer than the tract. The ends of this rod project slightly through the buccal mucosa and through the skin. Epithelization of the orifices and contraction occur while the rod is in position. It may be removed daily or at longer intervals for cleansing, if this is indicated. Circular skin flaps are raised around the fistulous opening and the opening of the new tract. The epithelial surfaces of these disks are scraped or shaved with a sharp knife. They are then approximated and fine silk sutures passed through quadrants of their peripheries (Fig. 82, *d*, C). The surrounding skin is undercut and closed by sliding. This leaves a very small facial scar and produces a functioning duct.

FACIAL PALSY

Nerve Injury and Repair

Paresis or total paralysis in the distribution of the facial nerve may result from one of the following: (1) surrounding infection, (2) refrigeration or toxemia (Bell's palsy), (3) injury to the nerve without loss of substance, (4) section of the nerve, and (5) loss of substance.

The lesion may occur intracranially in a manner that precludes repair. It may occur in the course of the seventh cranial nerve through its bony canal or in the soft tissues. The ultimate management of the

a piece of which will *not materially upset function* elsewhere. Such a nerve should be readily accessible and obtainable in any required length. A most suitable nerve for the purpose is the lateral femoral cutaneous. This is readily located on the anterolateral surface of the thigh, about 4 inches (about 10 cm.) below the inguinal ligament (Poupart's) and above the superficial layer of the deep fascia (Fig. 83).

RATIONALE OF METHOD.—The distal end of a severed nerve undergoes wallerian degeneration, in which the active cells are broken down and the detritus is removed by circulation, leaving empty tubules. The process requires about three weeks for completion. It

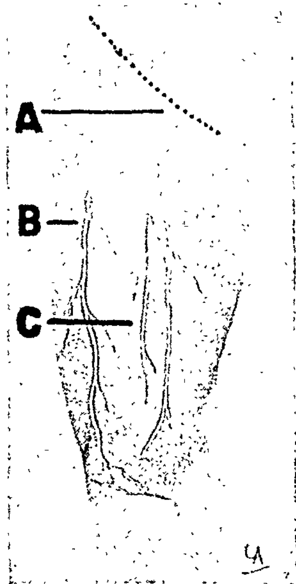


Fig. 83.—Anatomic location of the anterior and lateral femoral cutaneous nerves. A, Inguinal ligament; B, lateral femoral cutaneous nerve; C, anterior femoral cutaneous nerve.

was the general belief that neurons from the proximal end grew into the empty tubules when degeneration was completed.

Duel assumed in 1932 that recovery should be shortened if the implanted segment degenerated before transplantation and simultaneously with the process in the distal segment of the nerve. It has been the common practice to isolate a segment of sensory nerve and allow it to degenerate before transplantation. Bently (L. H.) of London has proved that few neurons pass through the tubules. They pass along the outside of the sheath of the distal segment to the ends of its branches. Consequently, it was believed that the *grafting could be done immediately.* This has proved true in many cases.

PROCEDURE.—The ends of the proximal and distal segments are

Make scrupulous preparation, including that of the ear canal. Expose the injured nerve immediately, if other conditions permit, to determine whether compression only or injury or section has occurred. Locate and use the digastric groove as a guide to the stylomastoid foramen. Remove sufficient mastoid cortex and cellular content to expose the horizontal semicircular canal. A line from this canal to the foramen marks the course of the nerve.

Begin removal of bone with rongeurs, small chisels, and curets. Start at the foramen and work upward to the lesion. Decompress. Slit the sheath freely above and below the lesion. Cover the open canal with a piece of fresh muscle, if the field is clean. Close the wound without drainage.

If the area is infected dress open daily with *saline solution. Do not use antiseptic* substances.

INJURY TO NERVE IN SOFT PARTS.—If the injury occurs between the *stylomastoid foramen* and the anterior border of the *parotid gland*, proceed as follows: Locate and use the digastric groove as a guide to the stylomastoid foramen. Follow the nerve to or into the parotid gland until the lesion is located. Decompress. Slit the sheath freely both proximal and distal to the lesion. This may be difficult or impossible to accomplish with reference to some of the smaller branches of the nerve web in the gland. Close the gland with fine, plain catgut. Close the wound without drainage, if clean.

INJURY TO NERVE DISTAL TO GLAND.—Locate the involved branches with the faradic current, if any response persists; otherwise by careful dissection. Proceed as above.

Section of Nerve.—If the break in continuity has occurred sharply, cleanly, and without laceration or crushing (stab wounds and so forth), the ends may be approximated by placing two or three fine sutures in the sheath.

Suture is not required in the bony canal if the ends are in approximation. In such a case, cover the point of approximation with a piece of clean muscle or permit blood clot to form over it. Avoid the presence of *blood during the approximation* of the two ends.

If laceration or crushing has occurred, the injured portion should be excised. If the loss is slight, the ends may still be approximated by freeing the nerve in its bed from the horizontal canal to the stylomastoid foramen. If loss is sufficient to preclude suture, proceed as below, under "Loss of Substance."

Loss of Substance.—Loss of nerve substance preventing suture of the proximal and distal ends requires introduction of new nerve tissue. Any nerve may be used, but one should be chosen, removal of

Muscular Reanimation and Fascial Support

Some nerve injuries are such in location or extent that repair is either impossible or impracticable. The surgeon must find some other means of restoring function or, at least, of masking the loss on the paralyzed side. He may resort to either of two procedures. One offers the possibility of restoration of action by *implanting functioning muscle* from the neighborhood. The nerves from this implant grow into the paralyzed muscle and "reanimate" it. It is asserted that its purpose is accomplished in approximately 40 per cent of cases. The other method consists in *implanting fixed supports* (fascia) in the paralyzed muscle and across the midline of the mouth into the functioning muscle. This maintains a balanced face and mouth during action of the normal muscles of expression (Figs. 85 and 86).

Muscular Reanimation and Fascial Support of Eyelids (Lagophthalmos).—Make a curvilinear incision over the midportion of the temporal muscle, so that the incision terminates inferior to the zygoma at a point about ½ inch (1.27 cm.) lateral to the external canthus. Reflect the flap forward to expose the temporal fascia (Fig. 85, *top*). Incise the skin over the medial palpebral ligament. Separate the muscle and isolate the ligament (Fig. 85, *top,* C). Remove enough of the superior border of the malar bone with rongeur forceps to permit free passage of temporal muscle strips to the eyelids. *Smooth* the cut surface of the bone (Fig. 85, *top,* A).

Divide the anterior portion of the temporal fascia and muscle into three equal strips (Fig. 85, *lower left,* A, B, C). Implant the anterior temporal strip in the outer third of the orbicularis oculi muscle in the lower lid. Suture. Implant the middle temporal strip in the upper lid in a similar manner. Suture. Implant the posterior temporal strip in the outer margin of the frontalis muscle in a similar manner. Suture.

Pass a large Reverdin or Blair needle beneath the skin of the temporal incision and beneath the skin and through superficial layers of the muscle of the upper lid near its free margin, so that the needle emerges in the incision by which the median palpebral ligament was exposed (Fig. 85, *top,* B, C). Fasten the needle to one end of a ribbon of fascia lata 6 inches (about 15 cm.) long, which has been stripped from the thigh, and draw it into the temporal incision (Fig. 85, *top,* D, and *lower left, E*). Wrap the other end of the fascial strip once around the palpebral ligament (Fig. 85, *top,* D, C). Pass the needle through the lower lid as described above and draw the free end of the fascial strip into the temporal incision (Fig. 85, *lower left,* E).

excised squarely in normal nerve tissue. A section of proper length is taken from the lateral femoral cutaneous nerve. Ends of this section are approximated squarely to the cut ends of the segments. These ends are sutured to maintain contact, if the injury occurs in the soft parts. They are covered, without suture, with fresh muscular tissue or blood clot in the bony canal.

Postoperative Course.—The patient and the surgeon must not be discouraged if early evidence of success is lacking. A satisfactory result has been noted in a case in which evidence of regeneration did



Fig. 84.—Facial palsy. *Left,* before nerve graft; length of graft, 16 mm.; *right,* appearance of patient three years later (Thomas G. Tickle).

not appear until the sixteenth month; further, reactivation of the orbicularis oculi and quadratus muscle groups has been noted as early as the third month. Action of these groups is frequently the first to appear. It becomes associated with muscular action about the mouth and may remain so associated for many weeks before dissociation occurs. The process of regeneration results in a new distribution in the muscles which apparently does not follow the original pattern.

Stimulation with *galvanic current* (interrupted anodal closure) for a few minutes once or twice a week should be continued until recovery has become complete (Fig. 84).

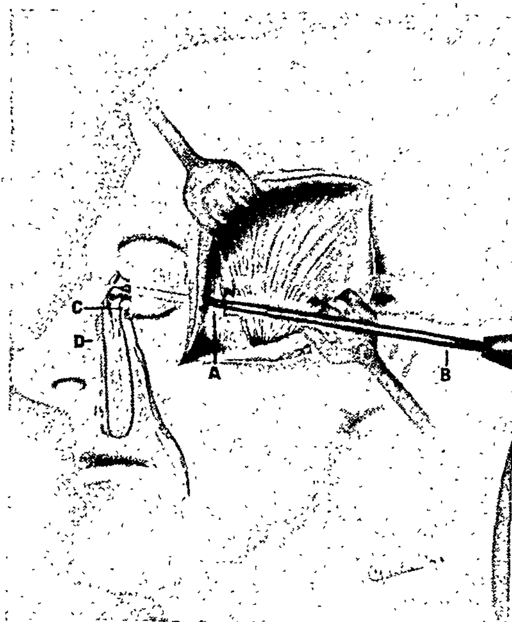
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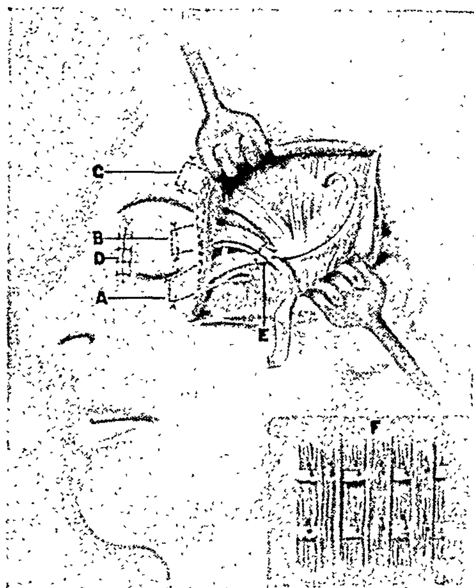




Fig. 85.—Muscular reanimation and fascial support for eyelids. *Top,* exposure of temporal muscle; preparation of the zygoma, A; insertion of fascial string in the eyelids, C and D; *lower left,* transplantation of strips of temporal muscle into the upper and lower lids and the frontalis muscle, A, B, and C; fixation of the fascial string of the temporal muscle, E; *inset,* fascial strips laced into the muscle and fixed with sutures, F; *lower right,* transplantation of strands of masseter muscle into the muscles of expression.

Cross the strips (Fig. 85, *lower left,* E, F) and interlace them into the remaining temporal muscle. Make traction on the ends to get the desired support in the lids. Pass sutures through the fascia and the

underlying muscle at the point of crossing, and through it and the temporal muscle as the fascia is woven through it (Fig. 85, *lower left,* E). Close without drainage.

Muscular Reanimation and Fascial Support of Muscles of Expression (Face, Mouth, and So On).—This is undertaken after the region of operation about the eye has become thoroughly organized (four to six weeks). Portions of the masseter muscle are used for this procedure.

PROCEDURE.—Incise through the skin and platysma muscle along the lower border of the mandible. Retract the skin and muscle to expose the masseter muscle and the muscles about the angle of the mouth (Fig. 85, *lower right,* A).

Segregate the anterior half of the masseter muscle and incise its attachment to the mandible. Insert the anterior strip into the junction of the angular and infra-orbital heads of the quadratus labii superioris muscle group. Suture (Fig. 85, *lower right,* B). Insert the median strip into the zygomatic muscle at the angle of the mouth. Suture (Fig. 85, *lower right,* C). Insert the posterior strip into the fibers of the orbicularis oris as they curve downward from the angle of the mouth around the lower lip. Suture (Fig. 85, *lower right,* D). Close without drainage.

Muscular Reanimation and Fascial Support of Frontalis Muscle.—This transplantation is made when there has been functional result from the other procedures.

Make a median incision and transfer a strip of muscle from the median border of the functioning frontalis muscle to the inactive one.

Mechanical Support: Fascial Strips

This method is used to stabilize the mouth and lower end of the nose during action of the muscles of expression on the normal side and to provide some expression to the palsied side.

The method is simple and generally efficient. The principle involved is an inelastic fixation of the paralyzed muscles to balance the traction of the opposing functioning group and to transmit some motion from the temporal muscle. Training is required to obtain dissociated muscular movement. In this manner the face remains balanced while speaking, laughing, singing, and so forth. The fascia is not absorbed but becomes vascularized and retains its characteristics.

Brown utilizes the temporal fascia and muscle for anchorage rather than the parotid fascia. This results in some *transmitted motion* to the palsied side and is a definite improvement over ordinary

fixed support. The approach from the temporal region hides the scar in the hair.

The preparation and technic must be faultless. Fascial transplants do not tolerate infection.

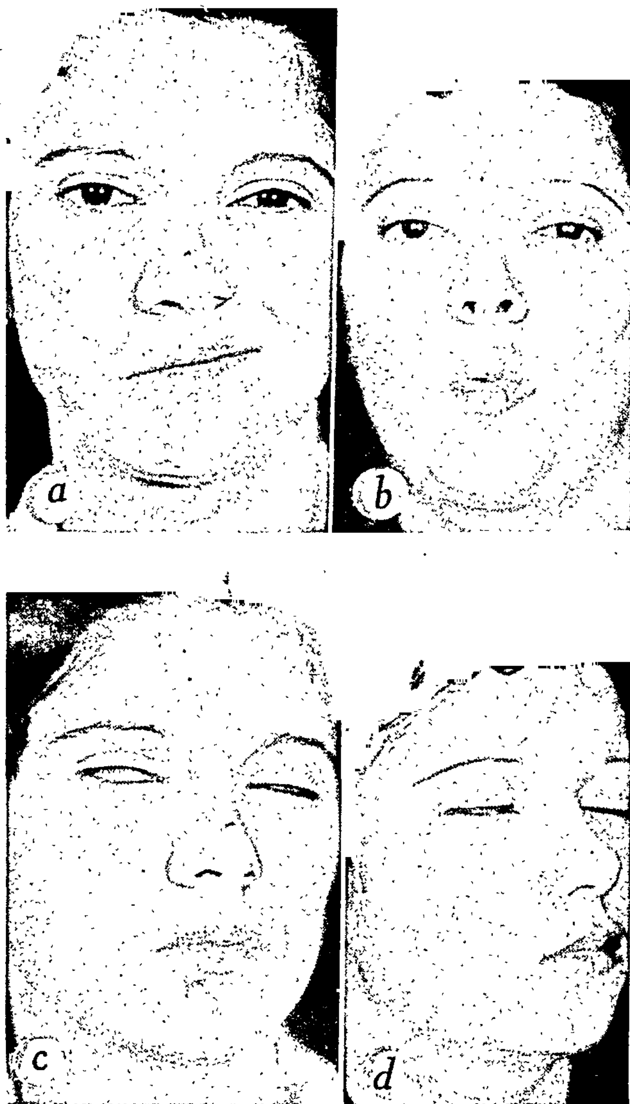


Fig. 86.—a and c, Appearance of patient before operation; *b* and *d*, appearance of patient one year later (Sheehan).

Procedure.—A curved incision 2½ inches (about 6.5 cm.) long is made in the hair area over the temporal muscle. The temporal fascia and muscle are exposed. A small incision is made in the nasolabial groove beside the nasal ala. A small, curved hemostat is tunneled

under the labial muscle to withdraw one end of a fascial strip. This end is incised about 3/16 inch (about 0.5 cm.) from its edge to receive the other end of the strip, which is now drawn through this incision (Fig. 87, A, D). The loop of fascia includes the muscle bundle. A Blair needle is passed from the temporal incision beneath

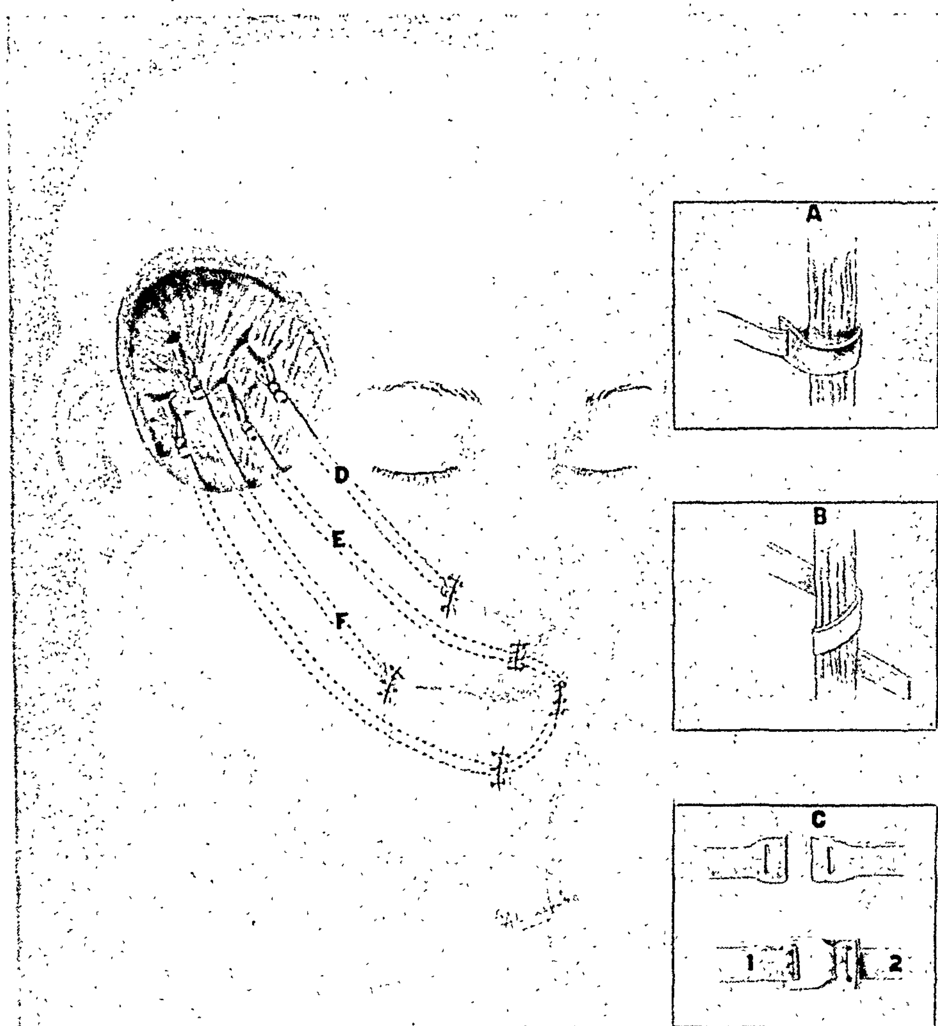


Fig. 87.—Distribution and fixation of fascial strips for mechanical support of mouth and lower end of nose. *Insets,* A, fixation of single strip around a muscle bundle; B, continuous fascial strip around a muscle bundle; C, splicing fascial strips. Letters and numbers on the face of the illustration which are not explained in the legend are accounted for in the text.

the skin and superficial fascia, through the nasolabial incision. The free end of the fascia is engaged and the needle withdrawn (Fig. 87, D).

A second fascial strip is passed around the mouth and to the temporal region in the following manner: A stab incision is made at

the angle of the mouth on the sound side. A bundle of muscle is tunneled as described above. A long fascial strip is wrapped at its midpoint, once around the muscle bundle (Fig. 87, B). Stab incisions are made just lateral to the midline on the normal side of the upper and lower lips. Muscle bundles are elevated as described above. The Blair needle is passed from each of these incisions, in turn, to the incision at the angle and an end of the fascia drawn through. These ends are wrapped once around the elevated muscle bundles (Fig. 87, B). The Blair needle is now passed from the temporal incision to each of these incisions in the lip, and the ends of the fascial strip are drawn out to the temporal region (Fig. 87, E).

A third loop of fascia is passed through the muscle about the angle of the mouth on the paralyzed side (Fig. 87, F). The free fascial ends are passed through the temporal fascia and muscle so as



Fig. 88.—Palsy of the seventh cranial nerve. *Left,* original condition; *middle,* six months after combined fascial support of the lids and anastomosis of the seventh nerve; the improvement is the result of the fascial support; *right,* condition one year later; result of reestablished muscular function (Blair and Byars: Surg., Gynec. and Obst., Feb., 1940).

to include about ½ inch (about 1.3 cm.) of muscle tissue. The first part of a knot is made in the fascial strip and pulled tight enough definitely to draw the sound side medially (overcorrection). The fascia is now fixed to the muscle in this position with No. 00 silk. The fascia may be interlaced as is shown in Fig. 85, F. Excess skin is removed and the wound is closed without drainage.

The *eyelids* (Fig. 88) are managed as is explained on pages 131 and 132 (Fig. 85, *top*).

Obtaining Fascia.—Strips ⅜ inch (about 1 cm.) wide are removed from the entire length of the thigh with a suitable stripper (Fig. 14). An incision 2½ inches (about 6.5 cm.) long is made above the knee, and the fascia is cleaned of fat as high as possible. A strip of the desired width is engaged as low as possible and is cut up to the tensor fascia femoris. The required lengths of fascia (three or four strips)

are removed in this manner. The incision in the skin is closed without drainage, and the thigh is firmly bandaged.



Fig. 89.—Facial palsy following section of the nerve in the bone and attempted nerve suture. *a* and *b*, Appearance of patient before support with fascial loops; c and *d*, appearance of patient three months later, after fixation of the paralyzed side with fascial loops (Blair: Ann. Surg., Oct., 1930. J. B. Lippincott Co.).

If the length of the fascial strips is not enough for the purpose, they can be smoothly spliced. These splices should not be made at the point of wrapping around muscle bundles (Fig. 87, C). Cut a slit

the angle of the mouth on the sound side. A bundle of muscle is tunneled as described above. A long fascial strip is wrapped at its midpoint, once around the muscle bundle (Fig. 87, B). Stab incisions are made just lateral to the midline on the normal side of the upper and lower lips. Muscle bundles are elevated as described above. The Blair needle is passed from each of these incisions, in turn, to the incision at the angle and an end of the fascia drawn through. These ends are wrapped once around the elevated muscle bundles (Fig. 87, B). The Blair needle is now passed from the temporal incision to each of these incisions in the lip, and the ends of the fascial strip are drawn out to the temporal region (Fig. 87, E).

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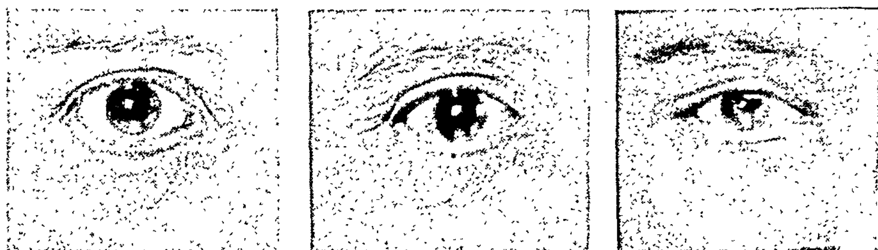


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CHAPTER V

RHINOPLASTY

TOTAL LOSS OF COLUMELLA

MOST methods of constructing a columella contemplate the use of flaps from the surface of the lip and adjacent parts of the face, with resultant increased cosmetic disability. The purpose of the surgeon is not only to provide the columella but to do this in a manner that does not add to the cosmetic disability. A satisfactory columella can be produced by one of three methods, without any added cosmetic disability. The skeletal anatomy of the nose is represented in Fig. 90. (For anesthetic procedures, see Section IV.)

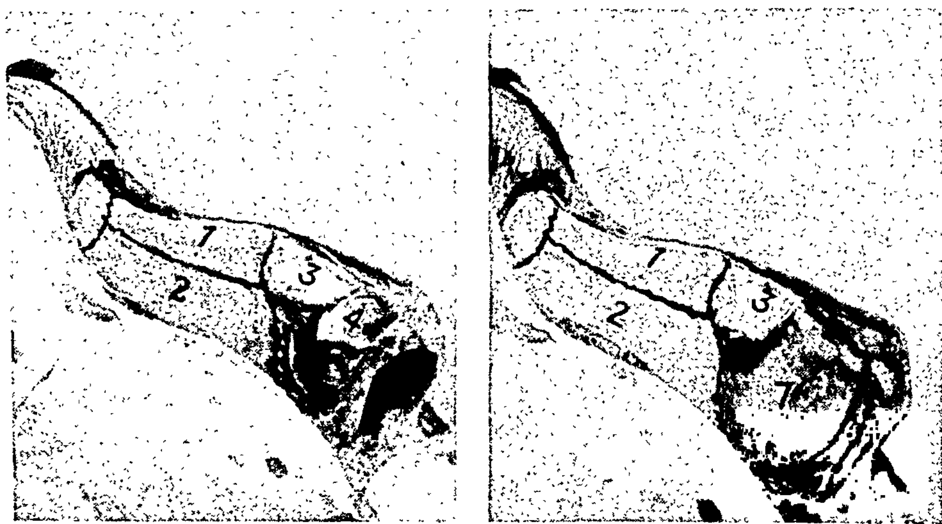


Fig. 90.—Skeletal anatomy of the nose. *Left, 1,* nasal bone; *2,* nasal process of superior maxilla; *3,* triangular (upper lateral) cartilage; *4,* alar crus of the tip (lower lateral) cartilage; the skin of the alar margin of the nostril presents immediately below this cartilage.

Right, 1, nasal bone; *2,* nasal process of the superior maxilla; *3,* triangular (upper lateral) cartilage; *4,* mesial crus of the tip cartilage; *5,* not shown; *6,* membranous septum; *7,* quadrilateral septal cartilage.

Reconstruction with Labial Mucosa and Split Skin Graft

Requirements.—A small skin tube, or a pedicle presenting skin anteriorly and mucous membrane posteriorly, of sufficient length to replace the lost tissue.

in the ends of the two strips to be spliced. Thread the end of one strip, 1, through the slit in the other, 2. Now pull the free end of strip 2 through the slit in strip 1 until the two strips have become firmly engaged. Fix with No. 000 silk sutures.

Dressing.—Cover the face with fluffed gauze or sterile waste and bandage firmly. Prohibit talking and other movement of the mouth. Feed through a Rehfuss tube for one week.

The face is supported and fixed after several days with gauze strips applied with collodion. These run from the side of the mouth to the temporal region. They are worn for several weeks.

In Fig. 89 is shown the result obtained in a case of facial palsy.

Procedure. STAGE 1.—Evert the lip and make two parallel incisions down the midline, including a flap of desired width through the mucosa and subcutaneous tissue. Undermine the subcutaneous tissue along a plane parallel to, and about $\frac{3}{16}$ inch (about 0.5 cm.) from, the surface of the mucosa. This produces a flap attached at both ends (Fig. 91, A). Insert a thick, split skin graft beneath the flap. Suture the flap and the incised edges of the mucosa with interrupted horsehair stitches (Fig. 91, A). Trim the excess graft and paint the stitch line with compound tincture of benzoin. Border the area with surgical glue and apply a piece of thin rubber tissue. Apply a gauze pad to the lip with a strip of adhesive tape, which is carried across the cheek on both sides to maintain firm pressure.

STAGE 2.—Stage 2 follows Stage 1 after an interval of two weeks.

Incise the superior attachment of the flap. Evert the lip and fix it in this position by a silver wire passed through a lead plate and fixed to the cheek with strips of adhesive tape (Fig. 91, B). Freshen the columellar stump at the nasal tip and fix the constructed columella to it with interrupted horsehair sutures. Undercut the mucosa bordering the defect in the lip and close with interrupted horsehair sutures (Fig. 91, C).

STAGE 3.—An interval of three weeks is allowed to elapse between Stages 2 and 3.

Incise the base of the pedicle. Make a small, H-shaped incision in the skin of the lip at the point of columellar attachment. Free the included rectangular flaps and suture to the base of the constructed columella. Close the defect in the lip (Fig. 91, C, D).

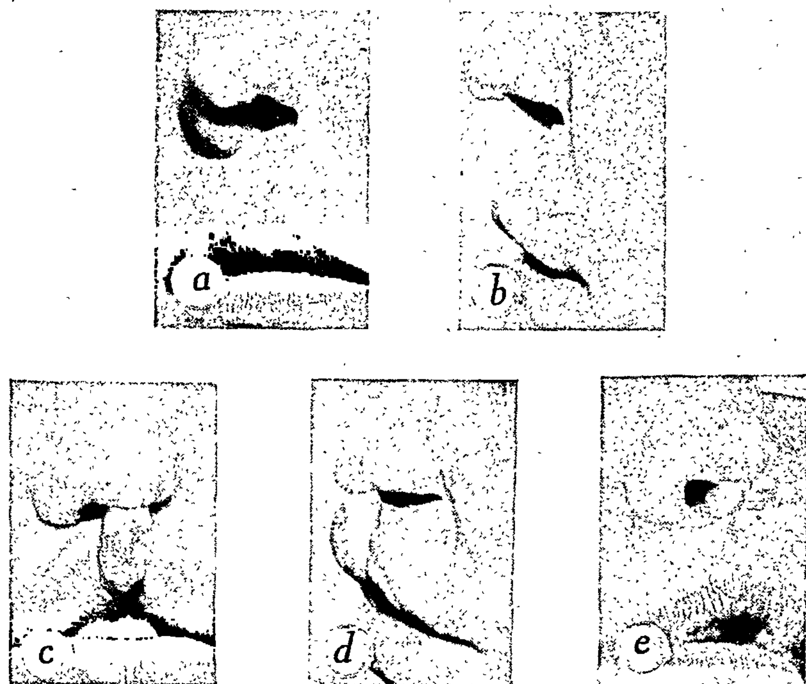
Value of Method.—The method produces a satisfactory columella without visible scar and with minimal inconvenience to the patient.

Reconstruction with Tubed Pedicle

A small, tubed pedicle can be elevated on the back of the hand, or it can be elevated on the body and transferred to the back of the hand for ultimate conveyance to the nasal defect (Fig. 9). Such a pedicle can be raised on the neck immediately beneath the margin of the mandible and transferred to the nasal tip, caterpillar-fashion (p. 18; see also Figs. 159 to 162).

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muscle; split skin graft in position; *c, d,* and B, superior end of mucosal flap sutured to the nasal tip; lip supported by a silver wire passed through a lead plate and the substance of the lip; wire fixed to cheeks with strips of adhesive tape; C, lead plate and wire removed; D, inferior end of columellar flap amputated from lip and sutured in position on the lip; e, appearance of patient after reconstruction. The reader should take care to distinguish between lower case and capital letters.



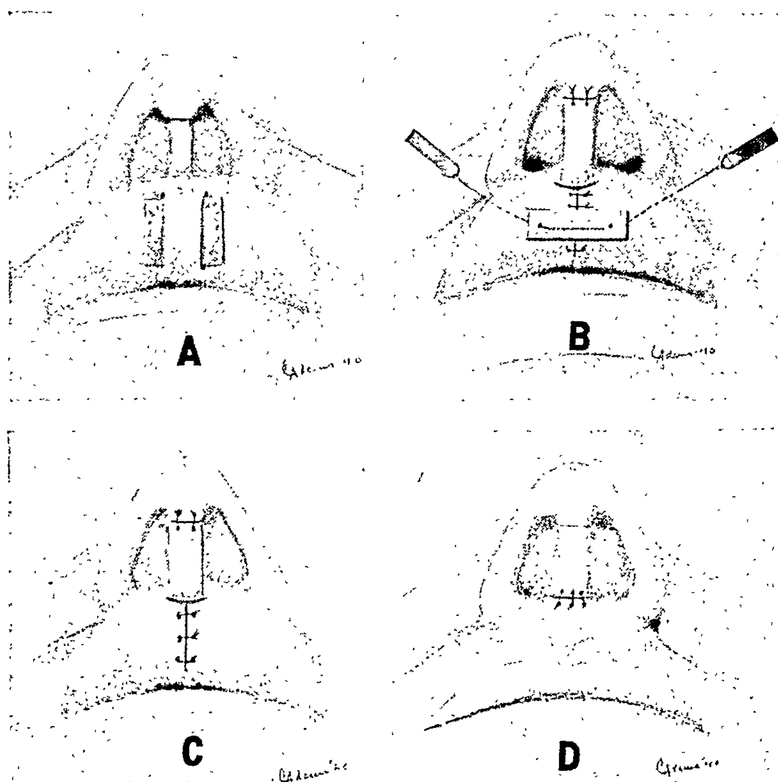


Fig. 91.—Total loss of columella. *a* and *b*, Appearance of patient before reconstruction; A, incised borders of a rectangular flap of mucosa and underlying

periosteum of the floor. Free the ala and its borders from the maxilla. Split the edges of the defect along the midline. Pass two vertical mattress sutures of silk to evert this split tissue and increase the thick-

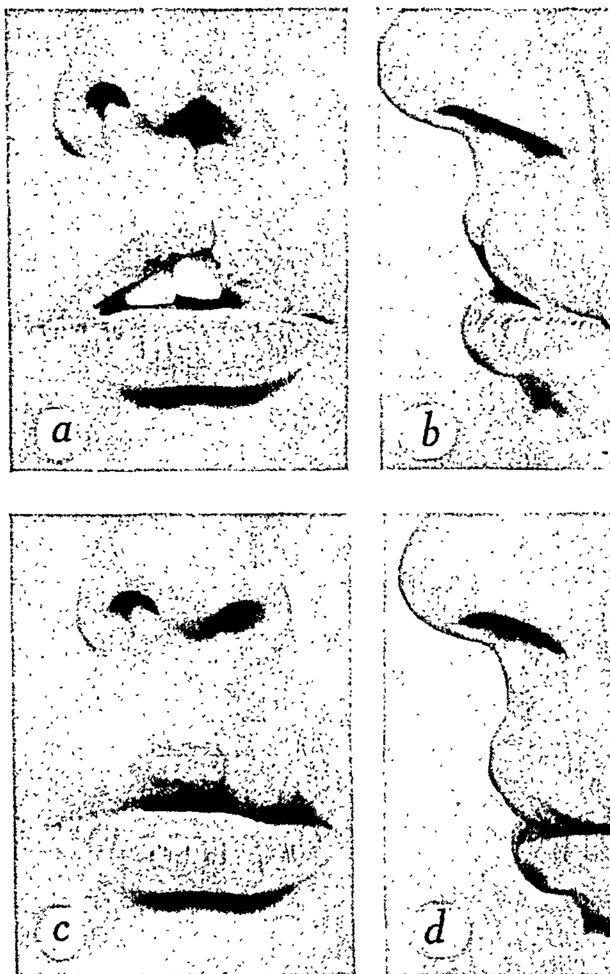


Fig. 93.—Loss of floor of the nostril. *a* and *b*, Appearance before operation; note nasal floor and ala and condition of lip; c and *d*, appearance six months following correction.

ness of the new floor. Approximate the skin with interrupted horsehair sutures (Fig. 93).

LOSS OF ALA: SKIN, CARTILAGE, AND LINING

In the case represented in Fig. 94, *b*, the loss was of the covering-skin portions, of the cartilage support and lining.

Requirements

Lining, skin for covering.

A similar tube can be constructed transversely just above the clavicle and "caterpillared" to the nose (see Fig. 160).

Reconstruction from Bordering Nasal Tissue

Follow the technic for reconstruction of the nasal tip described on page 153; see also Fig. 102. Allowance is made in designing the reflected nasal flap for a sufficient length to construct the columella.

SHORT COLUMELLA

Requirement

To lengthen the columella



Fig. 92.—Short columella. Gensoul's operation to increase the length. The dotted lines trace the course of the incision. The length of the flap on the lip is determined by the required elevation (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

Procedure

Incise the membranous septum from the tip to the base. Continue the incision on to the lip, as indicated by the dotted lines (Fig. 92), to provide a flap of sufficient length to compensate for the shortening. Dissect the flap, free from the tip of the nose. Elevate the nose to slight overcorrection. Approximate the borders of the flap with interrupted horsehair sutures. Undercut the skin bordering the defect in the lip and approximate with interrupted sutures.

LOSS OF FLOOR OF VESTIBULE

Procedure to Construct Floor

Determine and mark on the base of the columella the point of alar attachment. Mark a similar point on the ala. Excise the scar to the

dangering its blood supply. Return the flap to its bed and approximate with interrupted horsehair sutures. Repeat this delaying process until the blood supply remains adequate; then rotate the flap into the defect and fold the inferior border to produce a curved edge or cuff (Fig. 94, *d*, A).

Stage 2.—Incise the skin from the mucosal lining around the margins of the defect, except at the base of the flap. Suture the margins of the flap to the nasal lining with interrupted horsehair sutures which are passed from within outward and tied intranasally. Reflect the skin to form a rolled edge for the nostril and suture the reflected edge to the nasal skin at the tip (Fig. 94, *d*, A).

Outline and elevate on the cheek a sliding flap of sufficient length to close the defect in the cheek up to the nasofacial groove (94, *d*, B). Slide the flap into position and approximate with interrupted horsehair sutures (Fig. 94, e, B). Repair the remaining cutaneous defect on the ala with a full-thickness graft removed from the posterior surface of the ear (Fig. 94, e, C). (See also "Skin Grafting," p. 55.)

Pack the nostril smoothly with iodoform gauze ribbon. Cover the repaired area with a layer of gauze impregnated with scarlet red ointment. Add several layers of gauze, a piece of moist synthetic sponge about ½ inch (about 1.3 cm.) thick and a cotton eye pad that covers the entire nose. Apply a copper nasal splint and fix this to the cheeks with a strip of adhesive tape (Fig. 61). This dressing is not disturbed until the tenth or twelfth postoperative day in the case of a full-thickness graft; until the seventh or eighth day in case a thick, split skin graft has been employed. This may have the disadvantage of producing stitch scars if the stitches are tied tightly.

Result

The end-result of such a procedure is pictured in Fig. 94, *a*. The fulness resulting from folding or "hinging" the lining flap is noted on the edges of the nostril. This can be corrected secondarily.

DEFECT OF ALA AND COVERING SKIN

In the case represented in Fig. 95, the loss was of the following: alar margin; full thickness of alar substance and skin of the tip and side of the nose.

Requirements

Skin lining, skin covering.

Procedure

Stage 1.—Outline on the adjacent cheek a skin flap of proper dimensions to replace the lining defect and provide a rolled edge for

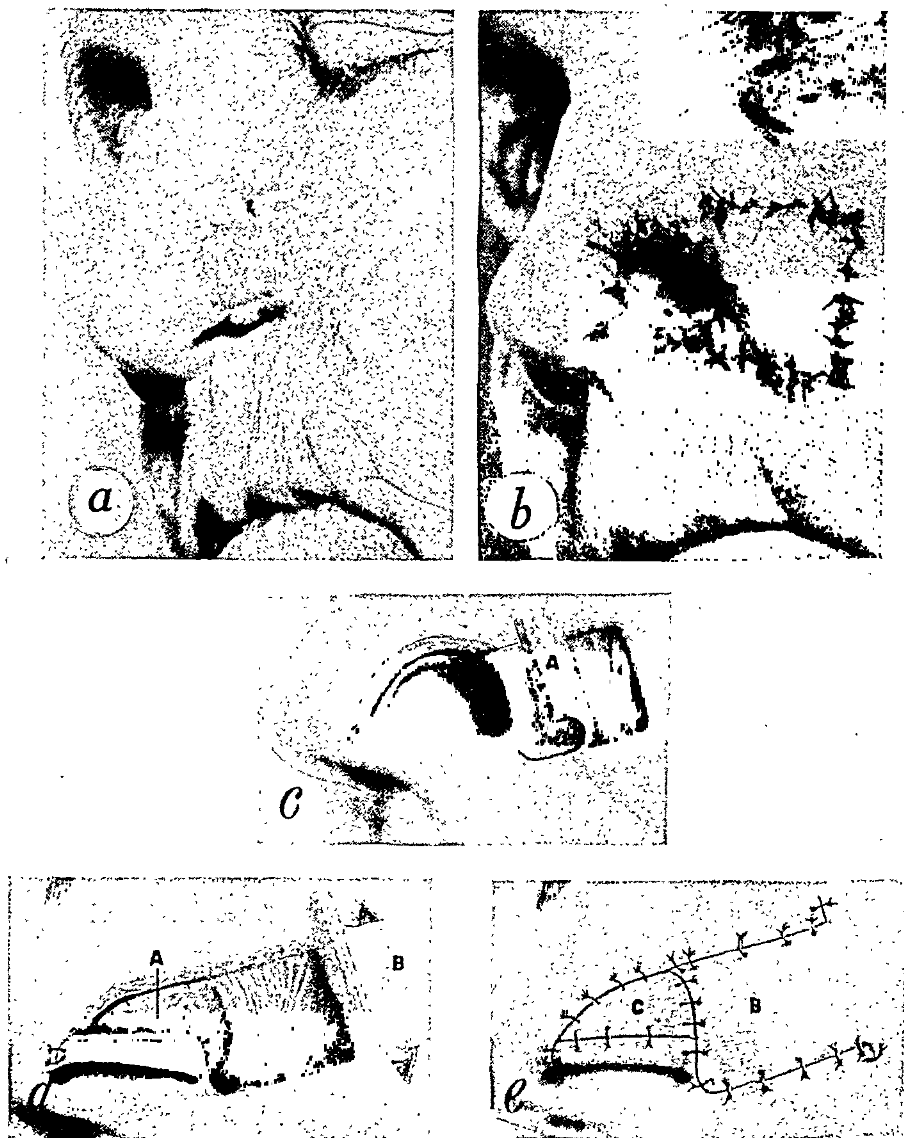


Fig. 94.—Alar loss. *a*, Appearance following reconstruction; *b*, former appearance; *c*, hinged flap to form nasal lining and rolled alar edge, A; *d*, lining flap and alar border in position, A; covering flap, B, dissected; e, covering flap, B, sutured in position; free graft, C, filling the alar skin defect.

the nostril. The base or hinge on which this flap will depend for blood supply is the tissue bordering the defect (Fig. 94, *c*, A). Incise the borders of the flap and dissect it free, as far as possible without en-

Procedure

Stage 1.—Outline a flap of sufficient proportions to supply the loss of lining and a cuff or rolled edge for the margin of the nostril on the lateral surface of the nose (Fig. 96, *d*, A). The base of this

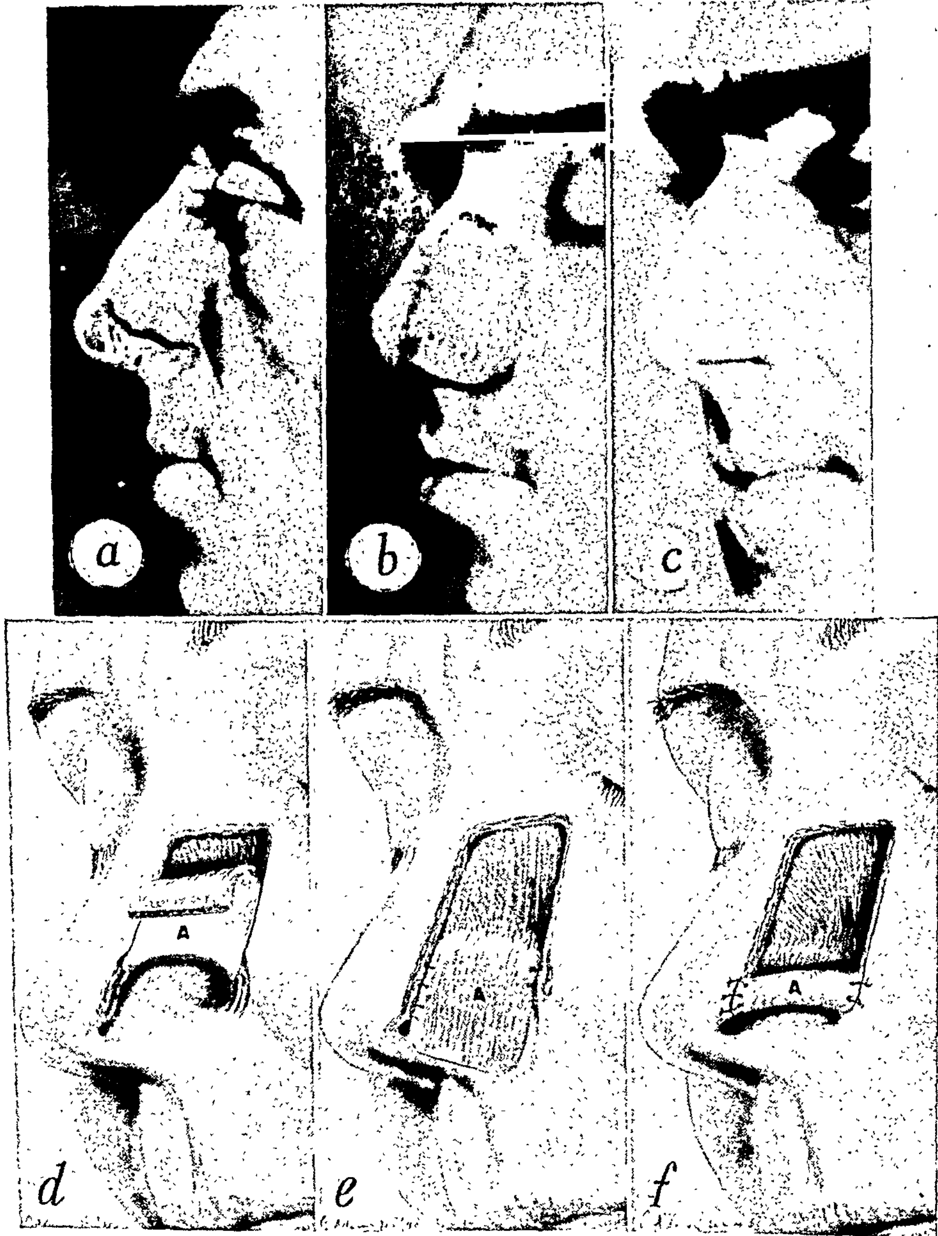


Fig. 96.—Total alar loss. *a*, Condition after the loss; nasal covering skin sutured to lining of mucous membrane; *d*, hinged lining flap, A, dissected from lateral surface of nose; *e*, lining flap, A, sutured to nasal lining; *f*, lining flap, A, folded on itself and sutured to the skin bordering the defect to form the alar margin; *b*, Wolfe graft from mesial surface of ear to replace loss of nasal skin; *c*, appearance six months after operation.

Procedure

This is the same as in the preceding operation. This case is exhibited to demonstrate the appearance of the graft at the time of removal of the splint and dressings, as well as the corrective procedures to remove the fulness resulting from hinging the lining flap.

The overlapping scar on the lip has been excised and the skin approximated. The defect resulting from elevation of the lining flap



Fig. 95.—*Left,* loss of total alar substance and skin on nasal tip; *middle,* appearance of covering graft immediately after removal of pressure dressing (twelve days); *right,* appearance six months later.

was closed in this instance by sliding the surrounding skin. This scar creates an added cosmetic disability of a minor degree.

TOTAL LOSS OF ALA

It is desirable, whenever possible, to confine the entire repair to the limits of the nose rather than to create further disabilities by obtaining either lining or covering tissues from the borders or from a distance. The procedure described in this instance is available to produce a most satisfactory result for both small and moderately large defects.

Loss

Skin covering, lining, and cartilages of the ala. The lining has been carefully approximated to the skin to provide adequate blood supply through a hinge, or base, of reflected lining flap (Fig. 96, *a, d*).

Requirements

Skin covering, lining, and in some cases a very thin cartilage support.

where on the body, but the resulting color is not so satisfactory as the full-thickness graft from the ear.

Pack the nostril smoothly with iodoform gauze ribbon. Cover the repaired area with a layer of gauze impregnated with scarlet red ointment. Add several layers of gauze, a piece of moist synthetic sponge about ½ inch (about 1.3 cm.) thick and a cotton eye pad that covers the entire nose. Apply a copper nasal splint and fix this to the cheeks with a strip of adhesive tape (Fig. 61).

Fig. 97 represents a case similar to that represented in Fig. 96.

Small defects resulting from the removal of flaps from the back of the ear can be corrected by undercutting and sliding the surrounding skin. Larger defects must be repaired by a thick intermediate or full-thickness graft removed from some other body surface (arm, thigh, abdomen, and so on). Such a graft is applied and dressed as already described (p. 56).

RECONSTRUCTION OF LATERAL NASAL WALL

Procedure

Stage 1.—Outline a rhomboidal lining flap with its base on the superolateral margin of the defect (Fig. 98, *e*). Incise, dissect, and delay this flap until its blood supply is adequate (p. 18). Split the covering skin from the lining along the anterior and lateral borders of the defect. Reflect the flap and suture its anterior border to the nasal lining, with interrupted catgut sutures, passed within the tissues so that the gut does not present intranasally (Fig. 98, *f*). Fold the distal end of the flap to form a rolled nostril cuff (Fig. 96, *f*). Suture the mesial border of this cuff to the skin of the alar defect and the lateral border to the skin of the cheek.

Dissect a flap, containing the anterior branch of the temporal artery, in the hairline of the scalp. This flap is so planned that its distal end is removed from a hairless area on the forehead. This portion of scalp of the forehead is of sufficient size to cover only the nasal skin defect. The flap must be sufficiently long to swing across the face without tension on its base. Its edges are approximated with interrupted horsehair sutures to form a tube. The flap can be utilized without delay because it contains an artery of sufficient size to guarantee its viability (Fig. 98, *b*). Swing the flap and approximate the skin of its distal end to the skin bordering the defect. Dress the scalp defect with boric acid ointment gauze.

Stage 2.—An interval of two to three weeks is allowed to elapse between Stages 1 and 2.

flap and its blood supply are formed by the union of the lining and skin at the upper margin of the defect. Incise and dissect this flap as freely as possible without damaging its blood supply. Return the flap to its base and approximate its edges with interrupted horsehair sutures. Repeat this delaying process at intervals of two weeks until the flap has an adequate blood supply, when it is reflected and its edges rolled to form the cuff.

Stage 2.—Split the skin from the lining on the mesial and lateral borders of the defect (Fig. 96, *d*). Elevate the flap, reflect it, and suture its borders to the nasal mucosa with interrupted horsehair



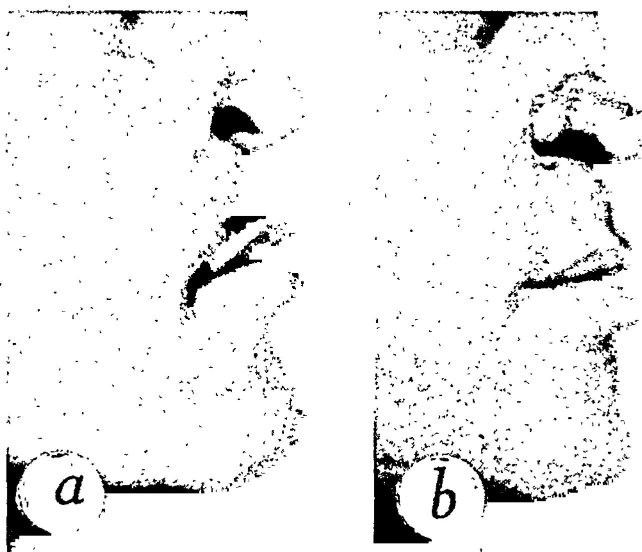
Fig. 97.—Full-thickness loss of the alar base. Procedure the same as that represented in Fig. 96. *Left*, lining flap dissected and sutured (delayed); *right*, final result of the repair.

sutures, which are passed from within outward and tied intranasally. This leaves a projection of the flap, which can be folded on itself to form the rolled edge of the nostril. The flap should be so folded and approximated to the skin covering that allowance is made for subsequent contraction (Fig. 96, *e*, *f*, A). Approximate the margins of the folded edge to the bordering skin with interrupted horsehair sutures (Fig. 96, *f*).

Repair the remaining skin defect with a full-thickness flap taken from the mesial surface of the ear. Approximate the graft with interrupted horsehair sutures tied lightly (Fig. 96, *b*). This defect may be repaired with a piece of thick intermediate graft taken else-

RECONSTRUCTION OF ALAR DEFECT

The loss in the case represented in Fig. 99 was of skin, lining, and margin of the supporting cartilage.



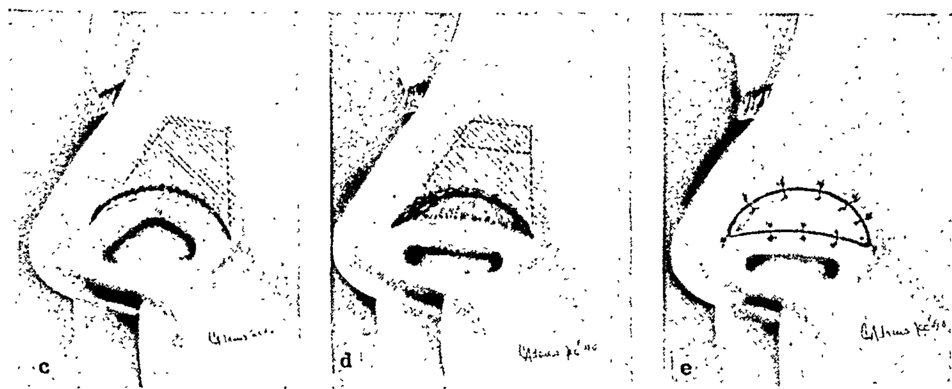


Fig. 99.—Partial alar loss (Kazanjian). Appearance of patient, *a*, before and, *b*, after reconstruction; *c*, incision in skin and area of dissected lining; *d*, restoration of normal level of alar border; dark, shaded area represents lining defect beneath nasal process; resulting defect in skin; *e*, graft repairing defect in alar covering.

Requirements

Lining, covering skin.

Procedure

Make a curved incision 2 to 3 mm. above the margin of the defect (Fig. 99, *c*). Carry the incision through the skin *to* the mucous membrane but not *through* the mucous membrane. Separate the mucous membrane from the underlying skin and beneath the nasal

Amputate the pedicle from the covering flap. Open it along the original suture line and return it to its source. Adjust the nasal cover

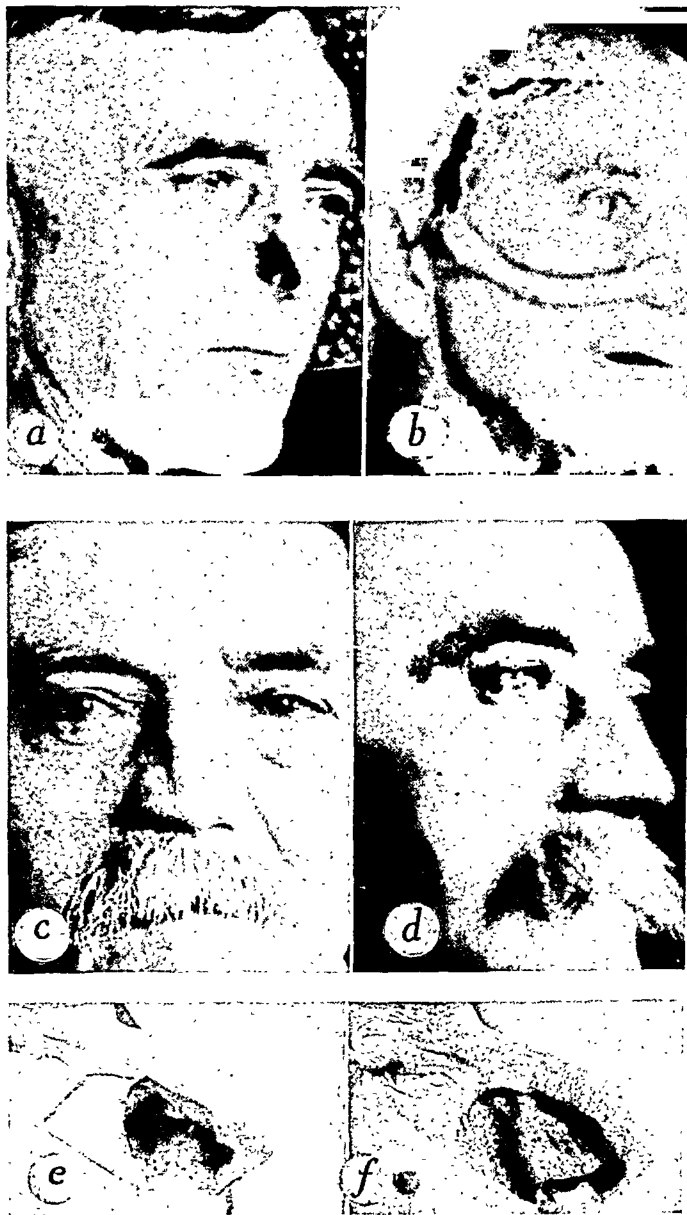


Fig. 98.—*a*, Partial loss of lateral wall of the nose; *e*, outline of lining skin flap; *f*, reflected lining flap; *b*, tubed scalp flap supplied by temporal artery; *c* and *d*, appearance of nose after reconstruction.

ing flap to the skin of the face and approximate it with interrupted horsehair sutures. Remove the sutures in two days and support the scar line with strips of gauze applied with collodion.

from the lining. This separates the lining in a manner to permit the nostril to be restored to its normal position. Repair the lining defect with a thick, split skin graft which is held in position by several interrupted horsehair sutures. Cover this graft with a piece of gauze permeated with scarlet red ointment and fill this portion of the nose smoothly with iodoform gauze ribbon. Apply a cotton eye pad and a metal splint externally (Fig. 61).

Remove the splint and dressing in six or seven days. Permit the graft to dry in air. Fill the nose with light iodoform gauze packing. Continue this until the graft has become properly organized.

Stage 2.—An interval of four to six weeks intervenes between Stages 1 and 2.

Reopen the original line of incision, dissect the covering skin from the lining, and insert a thin strip of preserved cartilage for support.

Pack the nose smoothly with iodoform gauze. Apply a cotton eye pad and a splint to the nose for several days. The end-result is pictured in Fig. 100, *right*.

RECONSTRUCTION OF NASAL TIP

Procedure

Stage 1.—Outline a skin flap based on the borders of the defect (Fig. 101A, *a*). Incise, elevate, and delay this flap until it has acquired a blood supply sufficient to permit its reflection and folding.

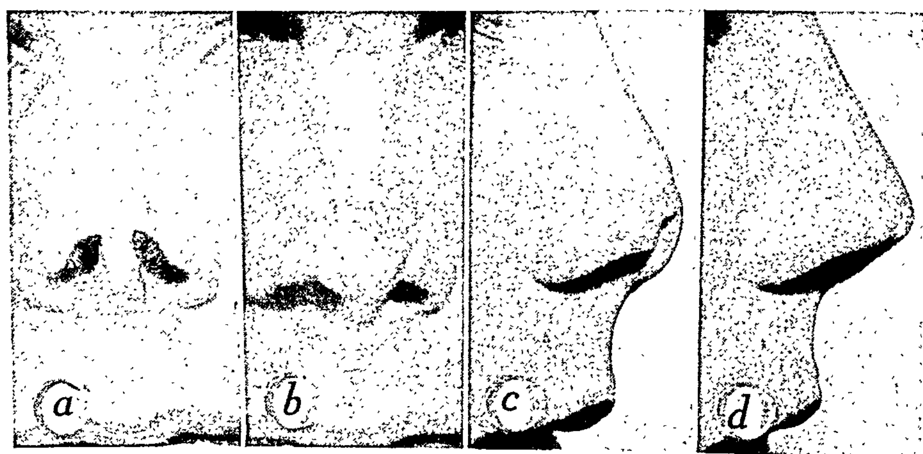


Fig. 101.—*a* and *c*, Loss of nasal tip and the tip attachments to the nasal alae; *b* and *d*, appearance after reconstruction.

Stage 2.—Split the skin from the lining around the borders of the defect. Reflect the flap and suture the border of its base to the lining of the defect (Fig. 101A, *b*). Fold the flap on itself so as to

process of the maxilla (Fig. 99, *c*). Incise the borders of the lining flap as indicated by the dotted lines in Fig. 99, *c*.

This will permit lowering of the border of the defect to the normal level of the nostril (Fig. 99, *d*), leaving the lining defect indicated in the shaded portion of the drawing. This defect occurs beneath the nasal process and is repaired by granulation, without distortion of the corrected portion. Repair the resulting defect in the skin noted in Fig. 99, *d*, with a full-thickness graft removed from the mesial surface of the ear (Fig. 99, *e*).

Pack the nostril smoothly with iodoform gauze ribbon. Cover the region of the repair with a layer of gauze impregnated with scarlet red ointment. Add several layers of gauze, a piece of moist, synthetic sponge about ½ inch (1.27 cm.) thick and a cotton eye pad that covers the entire nose. Apply a copper nasal splint and fix this to the cheeks with a strip of adhesive tape (Fig. 61). Close the skin defect in the ear by undermining and approximating the skin.

COLLAPSED NASAL TIP

The condition pictured in Fig. 100, *left*, resulted from infection and ulceration, with loss of lining and supporting cartilage.

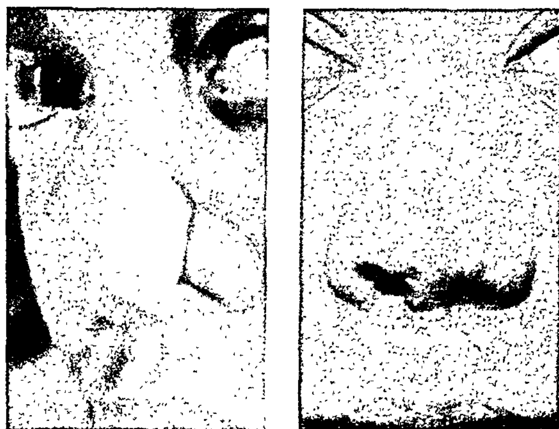


Fig. 100.—*Left*, collapsed ala; *right*, reconstructed ala; scar dissected; split skin graft in the lining defect.

Requirements

Skin lining and cartilage support.

Procedure

Stage 1.—Incise the intranasal skin from the tip to the base of the ala along a line 2 or 3 mm. above the nasal margin. Carefully dissect the skin from the underlying scar and lining. Dissect the scar

that covers the entire nose. Apply a copper nasal splint and fix this to the cheeks with a strip of adhesive tape (Fig. 61).

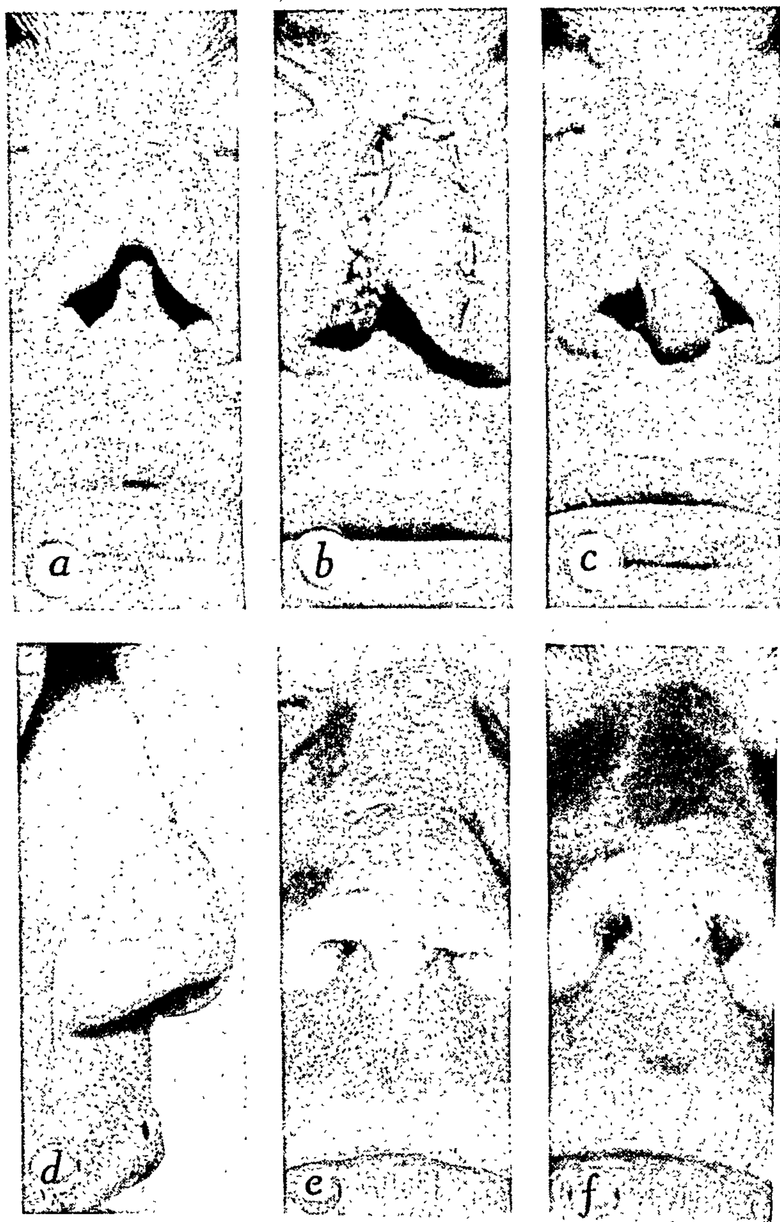


Fig. 102.—Loss of tip and columella. *a,* Appearance before reconstruction; *b,* nasal skin flap to form the lining of the tip and columella raised and "delayed"; *c* and *d,* nasal skin flap has been grafted with skin and rotated 180 degrees to replace the tip and columella; defect on the nasal ridge has been grafted with full-thickness skin from the mesial surface of the ear; *e* and *f,* readjustment of alar attachments; photographs fifteen days following operation.

Close the defect in the skin of the ear by undermining and approximating with interrupted horsehair sutures. The folded skin at the tip results in a knob or mound which much overcorrects the

produce the maximum of fulness at the tip. Suture the borders of the tip of the flap to the skin covering of the defect. Approximate it with interrupted horsehair sutures (Fig. 101A, *c*). Repair the nasal skin defect with a full-thickness graft taken from the mesial surface

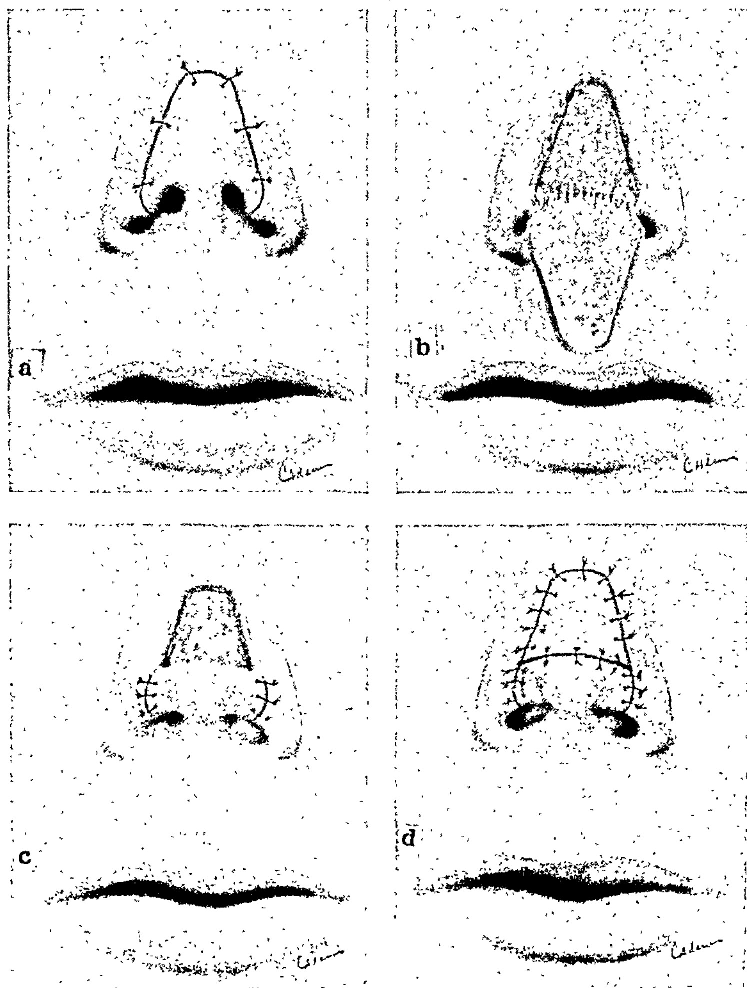


Fig. 101A.—Loss of tip and alar attachment. *a*, Nasal skin flap to form lining of reconstructed ala and tip of the nose; *b*, flap reflected and sutured to the lining of the alae; *c*, flap folded and sutured to the skin bordering the defect of the ala to produce a redundant skin mass at the tip; *d*, full-thickness graft filling the nasal skin defect.

of the tear. Approximate this with interrupted horsehair sutures, tied lightly (Fig. 101A, *d*).

Pack the nostril smoothly with iodoform gauze ribbon. Cover the repaired portion with a layer of gauze impregnated with scarlet red ointment. Add several layers of gauze, a piece of moist synthetic sponge about ½ inch (about 1.3 cm.) thick, and a cotton eye pad

collodion. Again apply the splint and continue to use it until organization has become complete.

Stage 3.—Incise the skin of the columella intranasally, from tip to base. Dissect a pocket in the columella and extend this in the

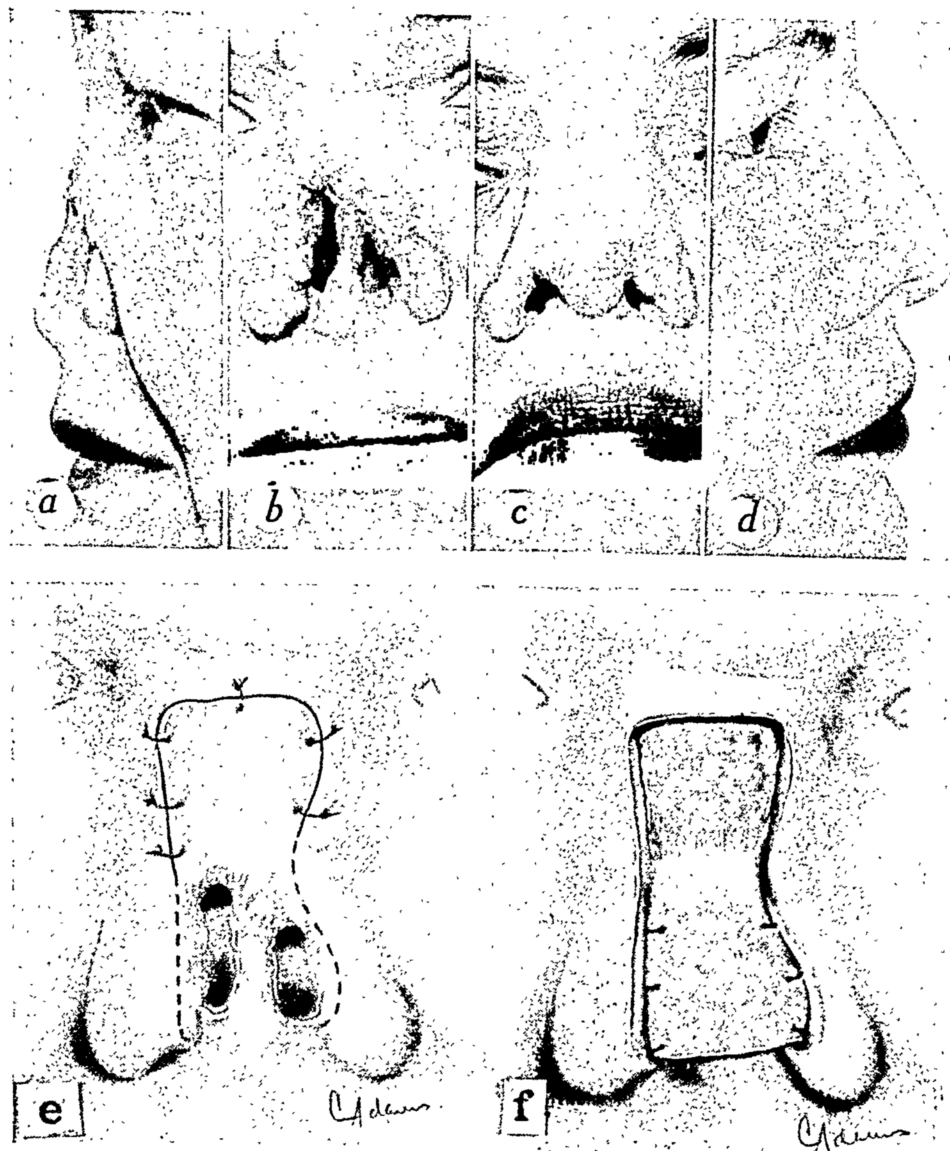


Fig. 103.—Loss of lower half of nose. Appearance of patient, *a* and *b*, before and, *c* and *d*, one year after reconstruction; *e*, outline of a skin flap to replace the loss of lining; *f*, flap reflected and sutured to the lining bordering the defect.

tissues of the lip to the anterior nasal spine. Dissect the covering skin from the lining along the nasal ridge and somewhat lateral to it on each side. Insert a properly shaped piece of prepared cartilage into the pocket to support the ridge, and a thin post of this cartilage into the columellar pocket to support the tip (Figs. 114, 115).

defect. This is provided to allow for subsequent organization and contraction. If the material present is in excess of the requirements, it can be readjusted after a period of six or eight weeks. The results of such a repair are depicted in Fig. 101, *b, d.*

A method of repair for loss of the tip and columella is represented in Fig. 102.

RECONSTRUCTION OF LOWER HALF OF NOSE

The loss in the case represented in Fig. 103 was of the structures of the lower half of the nose, except the base of the right ala and a small portion of the base of the left ala.

Requirements

Lining and covering skin, cartilage support.

Procedure

Stage 1.—A better end-result is obtained in most instances by amputation of alar remnants and complete reconstruction (Fig. 108). These remnants, however, are utilized in the reconstruction pictured in Fig. 103.

Outline a skin flap, with its base on the superior border of the defect, of sufficient proportions to replace the loss of lining (Fig. 103, *e*). Incise, dissect, and delay this flap until it has acquired an adequate blood supply for its reflection. Outline, incise, and elevate a properly formed forehead flap for construction of the columella, nostrils, and covering of the nasal cutaneous defect (Figs. 108, 109). Again approximate and delay this flap.

Stage 2.—Pare the lateral margins of the defect and split the skin from the lining tissues (Fig. 103, *f*). Elevate and reflect the flap. Approximate its borders to the lining membrane with a few interrupted horsehair sutures passed from within and tied intranasally (Fig. 103, *f*). Elevate the forehead flap and approximate its lateral edges to the skin bordering the defect, using interrupted horsehair sutures. Make an H-shaped incision at the site of the base of the columella; dissect the small rectangular flaps resulting from this incision. Approximate these flaps with interrupted horsehair sutures to the stump of the columella formed in the covering flap.

Pack the nose lightly with iodoform ribbon gauze. Apply a cotton eye pad and metal splint externally and fix it with strips of adhesive tape (Fig. 61). Remove the skin stitches on the second day and support the margins of the wound with strips of gauze applied with

Requirements

Covering skin and lining.

This is an adaptation of Monk's technic for reconstruction of an eyelid, which in turn is a modification of a method described by Dunham. The method is limited in its usefulness by the length of the frontalis artery and is applicable to the upper half or three-quarters of the nose. The frontalis artery usually terminates from ½ to ¾ of an inch (about 1.3 to 2 cm.) above the eyebrow.

Procedure

Stage 1.—Palpate the artery or locate it by measurement and outline the required flap at its termination (Fig. 104, *a*). Incise the borders of this flap, undermine it, and cover its undersurface with a thick, split skin graft. Approximate with interrupted horsehair sutures and cover with gauze dressing and firm bandage; continue to employ the dressing for ten days.

Stage 2.—Incise through the skin along the line of the artery and *flare* this incision on both sides to produce a triangular rod of subcutaneous tissue, including the artery and vein (Fig. 104, *b;* see also Fig. 145, *middle,* D). Incise the borders of the flap. Undermine the bridge of skin between the defect and the incision for the pedicle; the incision terminates in the glabellar region. Insert bullet forceps beneath the skin; grasp the margin of the flap and pull it into the defect (Fig. 104, *c*). Exercise care to prevent kinking of the artery and the vein at the bend. If this occurs, the incision must be carried lower on the nose to expose a greater length of artery and vein. Suture the graft into the margins of the defect with interrupted horsehair sutures (Fig. 104, *d*).

Undercut the scalp and approximate with interrupted horsehair sutures. Remove the sutures on the second day and support the wound with gauze strips applied with collodion.

SMALL, FULL-THICKNESS DEFECT IN NOSE WITH DEPENDENT TIP

In the case represented in Fig. 105, the position of the tip permitted removal of the bordering scar, undermining of the entire covering skin, approximation of the supporting and lining tissues, and ultimate readjustment of the covering skin. This resulted not only in repair of the defect but also in elevation of the tip, which improved the original cosmetic appearance. Such a method would not, obviously, be applicable to repair of a nose with a normally elevated tip.

Close the incision with interrupted horsehair sutures. Apply a cotton eye pad and metal nasal splint with strips of adhesive tape (Fig. 61). Place light iodoform ribbon gauze dressing in the nostril. The external splint is retained until organization has become complete. This firm splinting prevents collections of serum and blood and maintains the cartilage in position during the process of healing.

LOSS OF FULL THICKNESS OF UPPER HALF AND MIDDLE OF NOSE

In the repair to be described, a tunneled pedicle and flap, containing the frontalis artery was utilized.

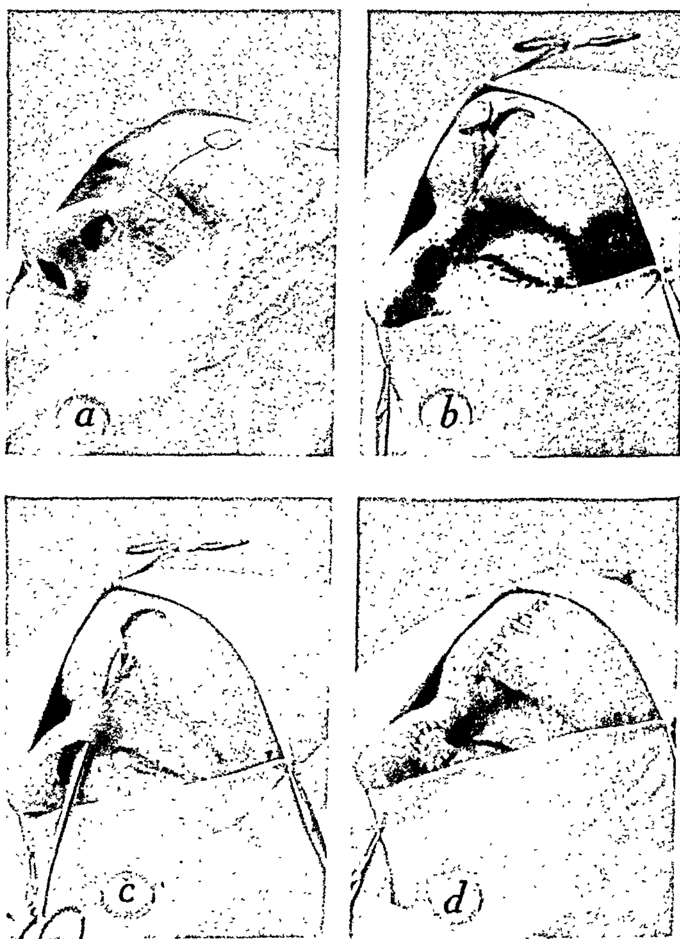


Fig. 104.—Loss of full-thickness of nasal wall; cadaver demonstration. *a*, Full-thickness defect in lateral wall of nose; line of frontalis artery and outline of a scalp flap on distal end; *b*, elevation of a scalp flap and frontalis vessels; *c*, flap and vascular pedicle being drawn under the tunneled skin; *d*, completed repair (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

(Fig. 61). Dress the defect in the forehead with boric acid ointment and gauze. Remove the stitches in the skin on the second day



Fig. 106.—*Left*, full-thickness loss of middle of nose; note defect from pressure in cartilaginous septum; *middle*, appearance after repair with a lining of skin from the border of the defect and a flap from the forehead for covering; *right*, final appearance, after correction of the saddle with a dermal graft.

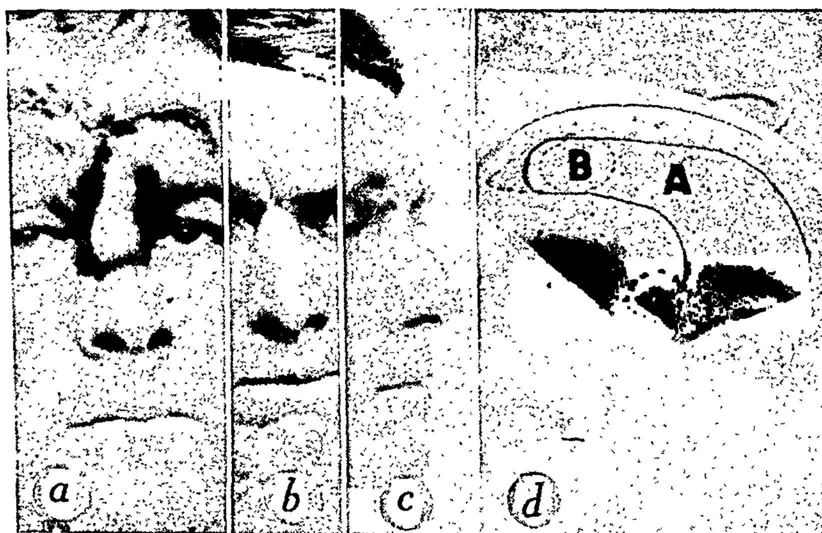


Fig. 107.—Full-thickness loss in glabellar region. *a*, Rotated, grafted flap from forehead; *b* and *c*, appearance immediately after reconstruction and healing; *d*, outline, A, of forehead flap containing frontalis and supra-orbital arteries; B, outline of portion grafted to replace nasal lining.

and support with strips of gauze applied with collodion. Continue the external dressing until organization has become assured.



Fig. 105.—Small, full-thickness loss in the center of a nose with a dependent tip. Repair was by excision of scar and simple suture. The result was elevation of the nasal tip (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

RECONSTRUCTION FOR LARGE FULL-THICKNESS DEFECT IN MIDDLE AND LOWER HALF OF NOSE

In the situation here in mind, the aim would be to utilize bordering skin for lining tissue and a pedicled flap from the forehead for covering.

Requirements

All elements of the nasal wall including cartilage support for the nasal ridge.

Procedure

Stage 1.—A lining flap of proper size and proportion is outlined on the nose with its base on the superior border of the defect (Figs. 106, *left,* and 96, *d*). Incise, dissect, and delay this flap until it acquires an adequate blood supply. Outline and elevate from the forehead a flap of proper proportions containing the left anterior temporal, supra-orbital, and frontalis arteries (Fig. 107, *d*). Incise, elevate, and rotate the forehead covering flap and approximate it in the margins of the defect with interrupted horsehair sutures. The cutaneous defect now continues to the glabellar region.

Pack the nose lightly with iodoform gauze ribbon. Apply a cotton eye pad and a copper splint to the nose with strips of adhesive tape

(Fig. 61). Dress the defect in the forehead with boric acid ointment and gauze. Remove the stitches in the skin on the second day



Fig. 106.—*Left*, full-thickness loss of middle of nose; note defect from pressure in cartilaginous septum; *middle*, appearance after repair with a lining of skin from the border of the defect and a flap from the forehead for covering; *right*, final appearance, after correction of the saddle with a dermal graft.

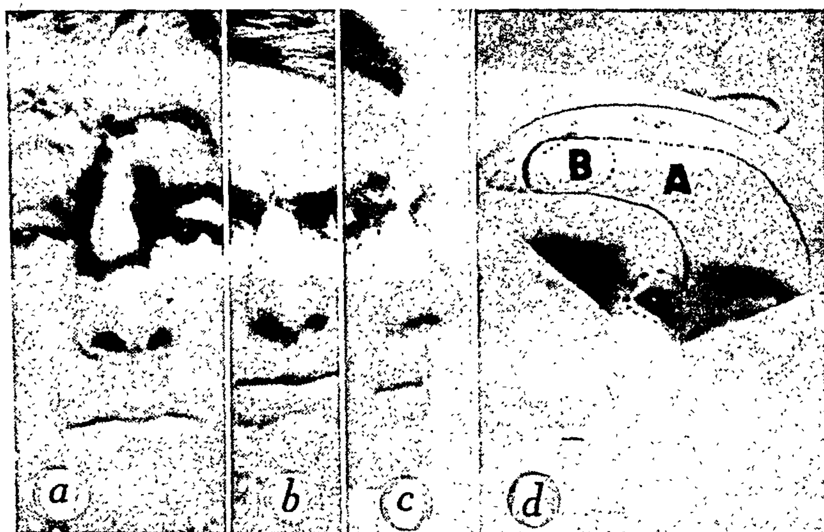


Fig. 107.—Full-thickness loss in glabellar region. *a*, Rotated, grafted flap from forehead; *b* and *c*, appearance immediately after reconstruction and healing; *d*, outline, A, of forehead flap containing frontalis and supra-orbital arteries; B, outline of portion grafted to replace nasal lining.

and support with strips of gauze applied with collodion. Continue the external dressing until organization has become assured.



Fig. 105.—Small, full-thickness loss in the center of a nose with a dependent tip. Repair was by excision of scar and simple suture. The result was elevation of the nasal tip (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

RECONSTRUCTION FOR LARGE FULL-THICKNESS DEFECT IN MIDDLE AND LOWER HALF OF NOSE

In the situation here in mind, the aim would be to utilize bordering skin for lining tissue and a pedicled flap from the forehead for covering.

Requirements

All elements of the nasal wall including cartilage support for the nasal ridge.

Procedure

Stage 1.—A lining flap of proper size and proportion is outlined on the nose with its base on the superior border of the defect (Figs. 106, *left*, and 96, *d*). Incise, dissect, and delay this flap until it acquires an adequate blood supply. Outline and elevate from the forehead a flap of proper proportions containing the left anterior temporal, supra-orbital, and frontalis arteries (Fig. 107, *d*). Incise, elevate, and rotate the forehead covering flap and approximate it in the margins of the defect with interrupted horsehair sutures. The cutaneous defect now continues to the glabellar region.

Pack the nose lightly with iodoform gauze ribbon. Apply a cotton eye pad and a copper splint to the nose with strips of adhesive tape

imate it to the borders of the defect with interrupted horsehair sutures (Fig. 107, *a*). Undermine the borders of the defect in the scalp and approximate with horizontal mattress sutures (Fig. 107, *a*).

Stage 3.—The interval between Stages 2 and 3 is three weeks. Amputate the pedicle and adjust it in its original bed (Fig. 107, *b*, c). Adjust the amputated border of the nasal transplant.

PLAN OF TOTAL NASAL COVERING

A mask of the defective face (Fig. 108) is obtained and a proper nose constructed from modeling clay. This model furnishes the desired measurements for reconstruction.



Fig. 108.—Construction of a total nose, cadaver demonstration. *Left,* lining reflected from borders of the defect; forehead covering flap incised; *middle,* distal end of forehead flap folded to produce skin-lined alae and a columella; *right,* forehead flap rotated and sutured in position (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

Procedure

Draw (Fig. 109) a horizontal line, AB, and erect a perpendicular line, PL, at its center. This perpendicular line will be the center, or ridge, of the nose. The point of intersection, L, of the two lines will become the point of union between the new columella and the lip.

Measure the distance from L to the anterior surface of the tip and mark this on the perpendicular line as T. Draw a line, XY, through this point, T, parallel to the base line. The included tissue will form the tip, alae, and columella. Measure the distance from the

Stage 2.—Amputate the pedicle of the flap and return the pedicle to its origin. Undercut the surrounding scalp and approximate it by sliding. If the defect is too large for this closure, it must be repaired with a full-thickness graft obtained from some other surface of the body. Adjust the skin in the glabellar region and close with interrupted horsehair sutures.

Stage 3.—An interval of six to eight weeks is allowed to elapse between Stages 2 and 3.

Incise the alar skin intranasally, along a line 2 or 3 mm. above the border of the nostril, from the tip to a point near the base of the ala. Separate the skin from the ridge and laterally, on each side, from the lining. Insert a properly shaped piece of prepared cartilage for support of the ridge (Figs. 114, 115). Close the alar incision with interrupted stitches of horsehair and pack the nostril lightly with iodoform ribbon gauze. Apply a cotton eye pad and copper nasal splint with adhesive tape (Fig. 61). This splint is retained until satisfactory organization has occurred.

Dermal graft may be utilized in place of cartilage for saddles of medium or small size (p. 23). This material can be implanted on several occasions until its ultimate organization produces the desired result.

RECONSTRUCTION FOR FULL-THICKNESS LOSS OF UPPER PORTION OF NOSE

For the situation contemplated here, a grafted, pedicled flap from the forehead is utilized.

Requirements

Lining and covering tissue.

Procedure

Stage 1.—Outline a flap including the supra-orbital and frontalis arteries, as pictured in Fig. 107, *d*, A. Incise the superior and inferior borders of the flap and elevate it by blunt dissection. Apply a thick, split skin graft of the desired size at its distal end (Fig. 107, *d*, B). Approximate the edges of the flap with interrupted horsehair sutures. Apply a firm, gauze dressing and continue to employ it for ten or twelve days.

Stage 2.—An interval of ten days to two weeks is allowed to elapse between Stages 1 and 2.

Pare the margins of the defect and split the skin from the lining tissues. Elevate and rotate the forehead flap 90 degrees and approx-

Procedure

Stage 1.—Rotate sufficient skin from either lateral border to furnish the entire nasal lining, except that of the vestibule of the nose (ala, tip, columella). Suture this with interrupted catgut (Fig. 108).

Outline a carefully planned forehead flap (Fig. 109) containing the anterior temporal, supra-orbital, and frontalis arteries in its base and retaining the anterior temporal artery at its distal end (Fig. 108, *left*). Incise the pattern of this flap, leaving a bridge of skin containing the temporal artery at its distal end; elevate the flap by blunt dissection, without injury to the elements of the epicranius (occipitofrontalis) muscle, and approximate its borders with interrupted horsehair sutures (delayed flap, p. 18). Dress with gauze and a firmly applied bandage. Remove the sutures on the second day and support the wound with strips of gauze applied with collodion. Elevate and delay this flap until its blood supply has become adequate.

Stage 2.—An interval of three weeks is allowed to elapse between Stages 1 and 2.

Elevate the flap and fold its distal end, after the plan of Petrali, to form the columella and the alar lining as depicted in Fig. 108, *middle*. Tack the formed lining to the overlying skin with a few fine, interrupted catgut sutures. Approximate the edges of the formed columella with a few interrupted horsehair sutures. Rotate the flap 90 degrees and approximate its borders to the bordering skin of the face with interrupted horsehair sutures (Fig. 108, *right*). Make an H-shaped incision in the skin at the point of attachment of the columella and undermine the small, outlined, rectangular flaps. Approximate these to the stump of the formed columella, with interrupted horsehair sutures.

Fill the nose with loose iodoform ribbon gauze. Apply a cotton eye pad and a copper nose splint externally and fix to the cheeks with adhesive tape (Fig. 61). Repair the scalp defect with a full-thickness (Wolfe) graft. Apply a layer of scarlet red ointment gauze and several layers of plain gauze with a firm bandage. Leave this in position for twelve days. Remove the nasal skin sutures on the second day after the day of their insertion; support with strips of gauze applied with collodion and again apply the metal splint. This splint is left in position until the healing and the organization have become satisfactory.

Stage 3.—An interval of three or four weeks is allowed to elapse between Stages 2 and 3.

Incise the skin of the columella intranasally, from tip to base.

tip, T, to the nasion, N, and mark this on the perpendicular line. Measure the height of an ala and mark this on the perpendicular line at HA. Draw a line, X^1Y^1, through this point parallel to the horizontal lines already plotted. Measure the distance from one alar labial groove over the tip to the opposite alar labial groove. Mark this measurement on the line XY so that the point, T, becomes its center. Erect perpendicular lines at the extremities of this measurement. Measure the width of the nose from one nasolabial groove to the other at the superior limit of the alae, X^1Y^1, at the nasion N,

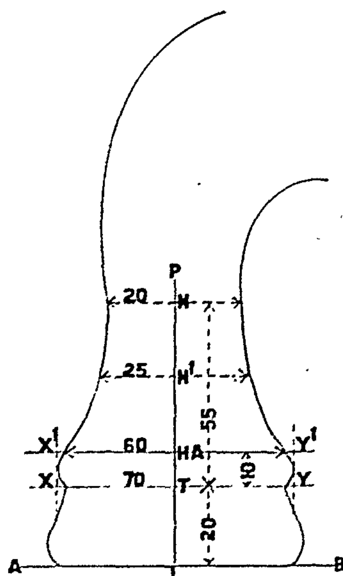


Fig. 109.—Plan of a total nasal skin covering. Letters and numbers on the face of the drawing are explained in the text.

and at the midpoint between, N^1. Mark these measurements, using the line PL as their center.

Now connect these points and lay out a pedicle of proper length and shape to include the nasal, frontal and anterior temporal arteries (Fig. 109).

TOTAL RECONSTRUCTION OF NOSE

The procedure contemplated here, to compensate for total loss of the nose, is planned to utilize an Indian type of flap and a lining obtained from the lateral skin borders (Fig. 110).

Requirements

Lining tissue, supporting tissue, covering skin.

lining along the nasal ridge and somewhat lateral to it on each side. Insert a properly shaped piece of prepared cartilage into the pocket to support the ridge, and a thin post of this cartilage into the columellar pocket to support the tip (Figs. 114, 115).

Close the incision with interrupted horsehair sutures. Apply a cotton eye pad and metal nasal splint with strips of adhesive tape (Fig. 61). Place a light iodoform ribbon gauze dressing in the nostril. The external splint is retained until organization has become complete. This firm splinting prevents collections of serum and blood and maintains the cartilage in position during the process of healing.

SUBTOTAL LOSS OF NOSE

Fig. 111 illustrates how this situation can be met.

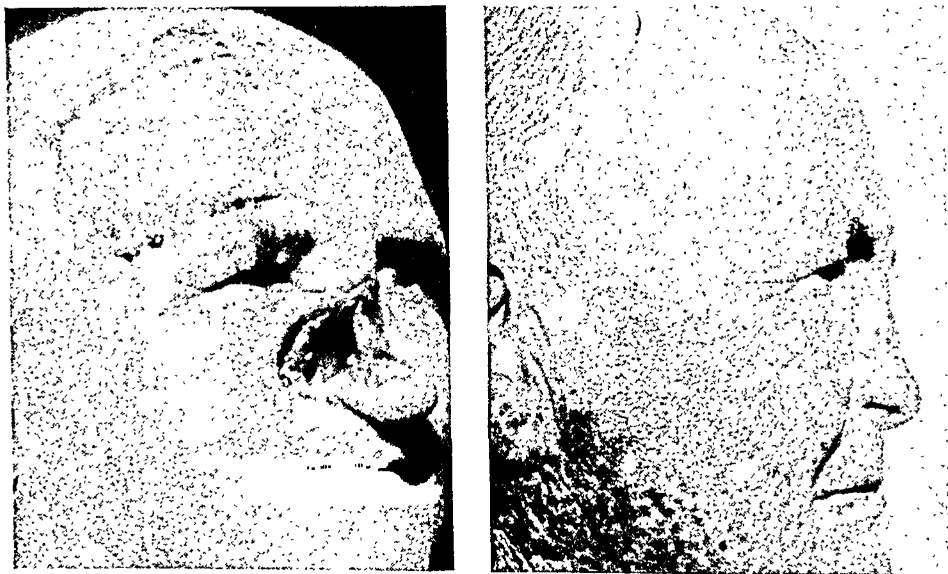


Fig. 111.—*Left,* subtotal loss of the nose and adjacent cheek; skin-grafted forehead flap containing the temporal, supra-orbital, and frontalis arteries; *right,* appearance fifteen months after reconstruction.

Prosthesis

A temporary prosthesis, molded from tinted latex or the acrylic resins, can be provided for the casualty during the period prior to final reconstruction. This will replace the usual dressing covering the loss and add greatly to the morale of the soldier.

Certain very extensive losses of supporting bony structure and soft parts may preclude a satisfactory reconstruction. A permanent prosthesis is supplied in these cases. (See "Maxillofacial Prosthesis," Section III.)



Fig. 110.—Total reconstruction of the nose. *a* and *b*, Loss of bony and cartilaginous support and of nasal lining; partial loss of lower half of nose; *c*, flap from forehead rotated and formed to reconstruct the nose; *d*, appearance six months after operation (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

Dissect a pocket in the columella and extend this into the tissues of the lip to the anterior nasal spine. Dissect the covering skin from the



Fig. 112.—Saddle nose. *Left* and *middle,* saddle nose attributable to loss of bony support; *right* appearance after reconstruction with implanted costal cartilage.

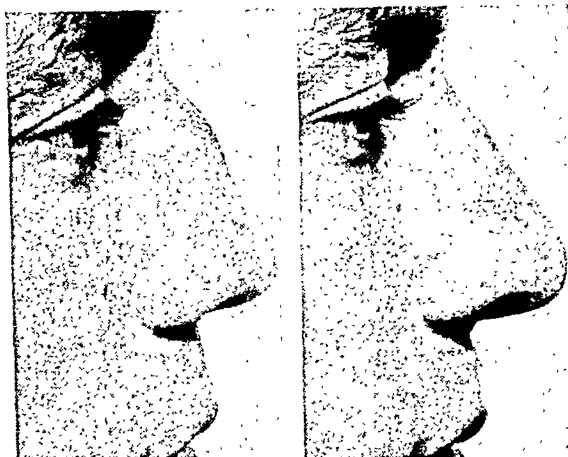


Fig. 113.—Saddle nose. *Left,* the effect of loss and displacement of the quadrilateral septal cartilage; *right,* appearance after implantation and organization of a dermal graft.

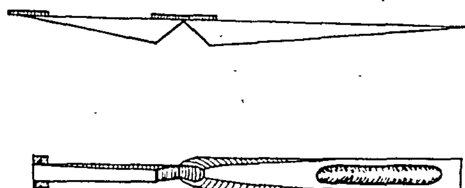


Fig. 114.—Plan and form of a nasal support formed by autogenous cartilage. A portion of the perichondrium is retained on the anterior surface of the point of the V-shaped notch, to permit hinging and abutment of the columellar and ridge portions of the implant (after Gillies).

about 20 per cent to allow for subsequent organization and contraction (Fig. 113; Fig. 106, *right*).

SADDLE NOSE

In the situation presented here, support of the nasal bony arch, or septal ridge, is lost (Figs. 112, 113, 114).

Requirements

Bone or cartilage or dermal support, or all three.

Procedure for Cartilage Support

Either autogenous cartilage from a free rib, or the last fixed rib, or preserved cartilage may be utilized. The availability, qualities, and behavior of implanted, preserved cartilage offer little excuse for the discomfort and disability following the procurement of autogenous cartilage (p. 22).

Make an intranasal incision in the skin from the tip to the base of the columella. Dissect the soft tissues to form a pocket in the columella and extend this inferiorly to the region of the anterior nasal process. Free the skin along the ridge from the tip to the glabellar region and laterally on each side. Insert a prepared ridge and columellar cartilage of proper shape. If autogenous cartilage is employed, a section of perichondrium may be left, as depicted in Fig. 114 (Gillies), to permit notching and hinging of the cartilage and its implantation in a single piece. If prepared cartilage is utilized, the distal (tip) portion of the cartilage must be mortised and the columellar post fashioned into a wedge-shaped point to insert into the socket. The two pieces are fixed in position with a catgut suture. This cartilage should have a thin ridge and a base adequate to repair the defect. Its tip should be carved to thin proportions in order to maintain the proper contour of the region.

Close the columellar incision with interrupted horsehair sutures. Apply a cotton eye pad and copper nose splint with strips of adhesive tape (Fig. 61).

RECONSTRUCTION FOR SADDLE IN LOWER HALF OF NOSE

The defect that is in mind here is attributable to loss or displacement of the quadrilateral cartilage. Dermal graft is utilized.

Procedure

Preparation of the field is the same as described above. The skin for the dermal graft is obtained and inserted as described on page 23. Closure and dressing are described in the foregoing. The splint is retained for seven or eight days to control the swelling and prevent bloody and serous collections. The defect should be overcorrected

for replacement of the lining. This opening can be made in one of several ways: (1) The nasal cavity can be opened through an incision made in the buccal sulcus beneath the lip. (2) It can be opened as depicted in Fig. 115, *a, b.* (3) It can be opened through an incision along the nasolabial groove, extending from the inferior margin of the nasal process of the maxilla on one side, upward across the glabellar region and downward to a similar point on the opposite side. In this procedure the soft parts are dissected free from the bone, and the scar is dissected from the margins of the glenoid fossa. The procedure through this approach varies materially from the one to be described. It contemplates the introduction of a pedicled forehead

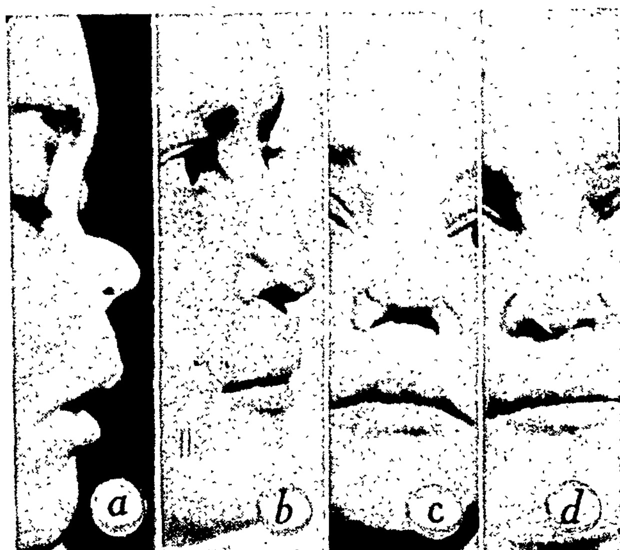


Fig. 116.—Reconstruction for nasal saddle, by procedure pictured in Fig. 115. Appearance in profile, *a,* before and, *b,* after reconstruction; anterior view, *c,* before and, *d,* after reconstruction (Smith, Ferris: Reconstructive Surgery of the Head and Neck. Thomas Nelson and Sons).

flap to furnish the lining and the supporting tissue. The base of this pedicle is subsequently amputated and returned to its bed as described on page 163.

Stage 1.—Begin an incision in the nasolabial fold at the upper margin of the ala; carry it around the ala, beneath the lower margin of the nostril and the base of the columella, then along a similar line beneath the opposite nostril, and finally along the nasolabial fold of the opposite ala (Fig. 115, *a, b*). Dissect the lower end of the nose free (Fig. 115, *b*) and remove all of the involved scar tissue.

Make a mold of plastic dental modeling compound of proper size to restore the normal shape of the lower half of the nose (Fig. 115, *c*). This modeling compound is sterilized by boiling and is allowed to

RECONSTRUCTION FOR SADDLE NOSE

The defect, in the situation contemplated here, is attributable to loss of bony support and lining (Fig. 116).

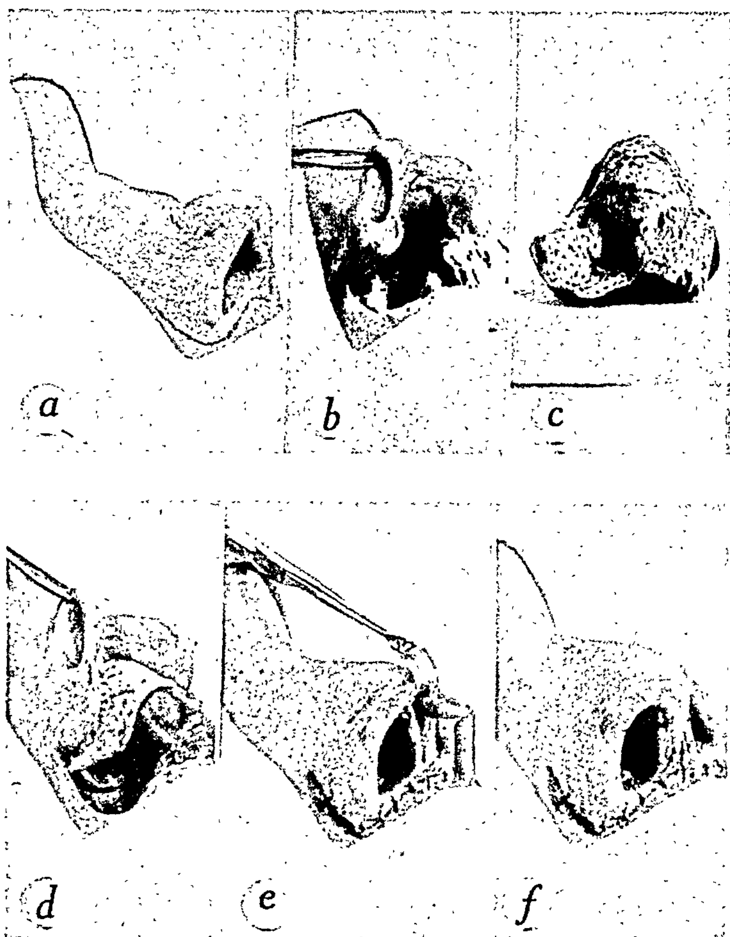


Fig. 115.—Saddle nose, the result of loss of bony support and lining. Cadaver demonstration. *a*, Condition before reconstruction; outline of an incision to expose the interior of the nose; *b*, contracted scar lining removed from interior of nose and borders of the glenoid fossa, to release nasal soft parts; *c*, thick, split skin graft over a dental compound model to replace the loss of lining; *d*, mold and graft in position in the nose; *e*, implantation of cartilage to support the nasal ridge and columella; *f*, appearance after reconstruction.

Requirements

Removal of scar, addition of lining and supporting tissue.

Procedure

The interior of the nose must be approached through an opening which will permit complete removal of the contracted, adherent scar which produces the deformity and which will afford an opportunity

Stage 2.—An interval of eight to ten days is allowed to elapse between Stages 1 and 2.

Reopen the incision and remove the mold of modeling compound. Close the incision with interrupted horsehair sutures. Place a moderately firm dressing of iodoform ribbon gauze in the grafted region. Repeat this dressing daily until the skin has become thoroughly organized.

Stage 3.—The interval between Stages 2 and 3 is six weeks.

Incise the skin of the columella intranasally on each side and connect these incisions across the base. Elevate the skin of the columella and separate the skin from the grafted lining along the ridge. Continue this separation to the glabellar region and laterally on each side. Insert a properly shaped cartilage to support the ridge and the tip (Fig. 115, e).

Approximate the skin of the columella with interrupted horsehair sutures. Apply a cotton eye pad and a copper nasal splint with strips of adhesive tape and continue to employ these dressings until organization has become complete (Fig. 61).

Alternate Procedure

If the interior of the nose is approached through an intra-oral incision, the mold of modeling compound can be supported on a prosthesis attached to bands or a splint on the upper teeth (Fig. 117, *a*, *b*). The mold is removed at the end of seven to ten days, and is cleaned, dried, and reinserted at proper intervals until the organization of the graft has become complete and the cartilage support is to be inserted. Various types of prosthetic support can be devised and fitted in dental laboratories (Fig. 117, *c*, *d*).

REPLACEMENT OF NASAL COVERING SKIN

The loss, in the situation contemplated here, is of the entire nasal covering following a burn.

Requirement

Skin of a texture and color that will match the surrounding skin. This skin can be obtained from the forehead with a pedicled flap. However, such a course produces considerable cosmetic disability, which can be avoided by utilizing the entire skin from the posterior surfaces of both ears.

Procedure

The scarred skin is removed from the entire nose, and distortions such as that noted in the left ala in Fig. 118, *b*, are corrected by re-

cool to a degree at which it will remain plastic. The nasal cavit filled with the compound, and the external nose is returned to normal attachment and is modeled over the compound. The c pound becomes hard and is readily removed after cooling.

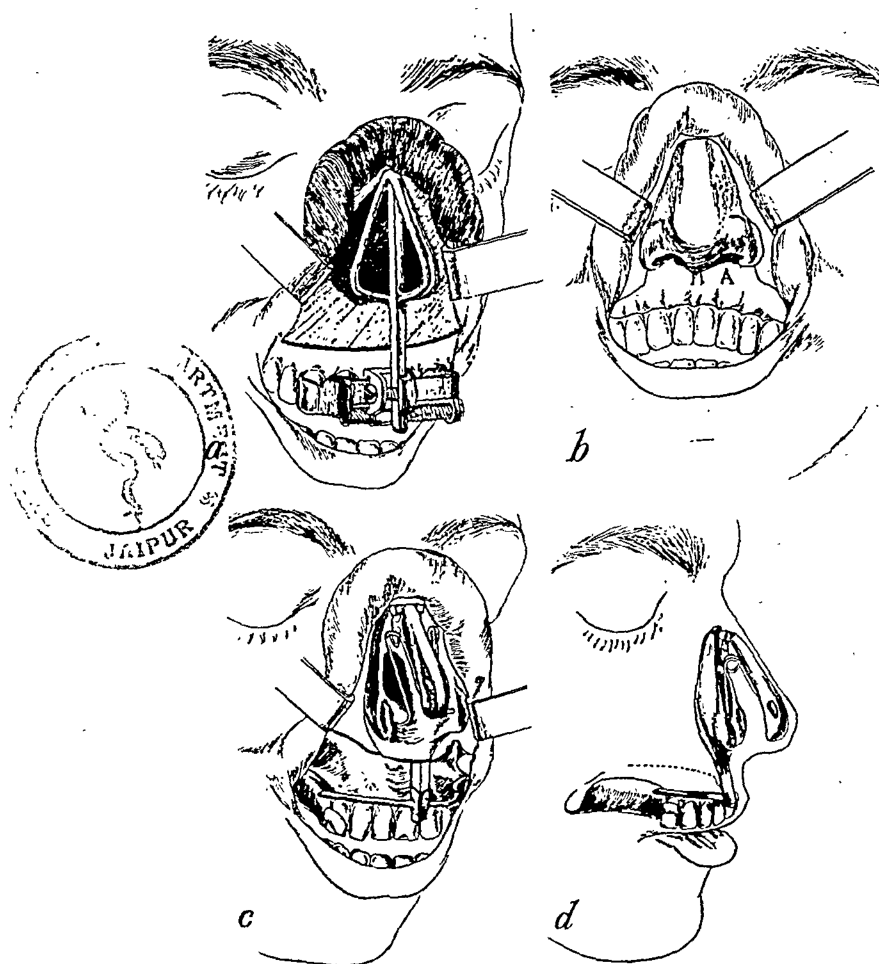


Fig. 117.—Prosthetic appliances, with dental attachment to maintain n in normal position during, and subsequent to, its lining with skin graft. *a*, M frame introduced into nose beneath lip and attached to dental caps; *b*, fra work covered with dental modeling compound; c and *d*, appliance to maint shape of nose during organization of skin graft and prior to implantation of tilage support (after Gillies from Sheehan: Plastic Surgery of the Nose. P. Hoeber, Inc.)

Cover the mold with a thick, intermediate skin graft, raw s face outward, and insert it in position (Fig. 115, *c*, *d*). Adjust t nasal soft parts over the mold and close the line of incision w interrupted horsehair sutures (Fig. 115, *e*). Apply a cotton eye p and a nasal splint, using strips of adhesive tape (Fig. 61).

Stage 2.—An interval of eight to ten days is allowed to elapse between Stages 1 and 2.

Reopen the incision and remove the mold of modeling compound. Close the incision with interrupted horsehair sutures. Place a moderately firm dressing of iodoform ribbon gauze in the grafted region. Repeat this dressing daily until the skin has become thoroughly organized.

Stage 3.—The interval between Stages 2 and 3 is six weeks.

Incise the skin of the columella intranasally on each side and connect these incisions across the base. Elevate the skin of the columella and separate the skin from the grafted lining along the ridge. Continue this separation to the glabellar region and laterally on each side. Insert a properly shaped cartilage to support the ridge and the tip (Fig. 115, *e*).

Approximate the skin of the columella with interrupted horsehair sutures. Apply a cotton eye pad and a copper nasal splint with strips of adhesive tape and continue to employ these dressings until organization has become complete (Fig. 61).

Alternate Procedure

If the interior of the nose is approached through an intra-oral incision, the mold of modeling compound can be supported on a prosthesis attached to bands or a splint on the upper teeth (Fig. 117, *a*, *b*). The mold is removed at the end of seven to ten days, and is cleaned, dried, and reinserted at proper intervals until the organization of the graft has become complete and the cartilage support is to be inserted. Various types of prosthetic support can be devised and fitted in dental laboratories (Fig. 117, *c*, *d*).

REPLACEMENT OF NASAL COVERING SKIN

The loss, in the situation contemplated here, is of the entire nasal covering following a burn.

Requirement

Skin of a texture and color that will match the surrounding skin. This skin can be obtained from the forehead with a pedicled flap. However, such a course produces considerable cosmetic disability, which can be avoided by utilizing the entire skin from the posterior surfaces of both ears.

Procedure

The scarred skin is removed from the entire nose, and distortions such as that noted in the left ala in Fig. 118, *b*, are corrected by re-

moval of contracted scar. The skin of the entire posterior surface of both ears is removed and applied to the nasal bed as described on pages 55 to 59. The color of this skin is usually satisfactory.

The defect in the ear is repaired with thick, split skin obtained from some other surface of the body. The nose is covered with one or

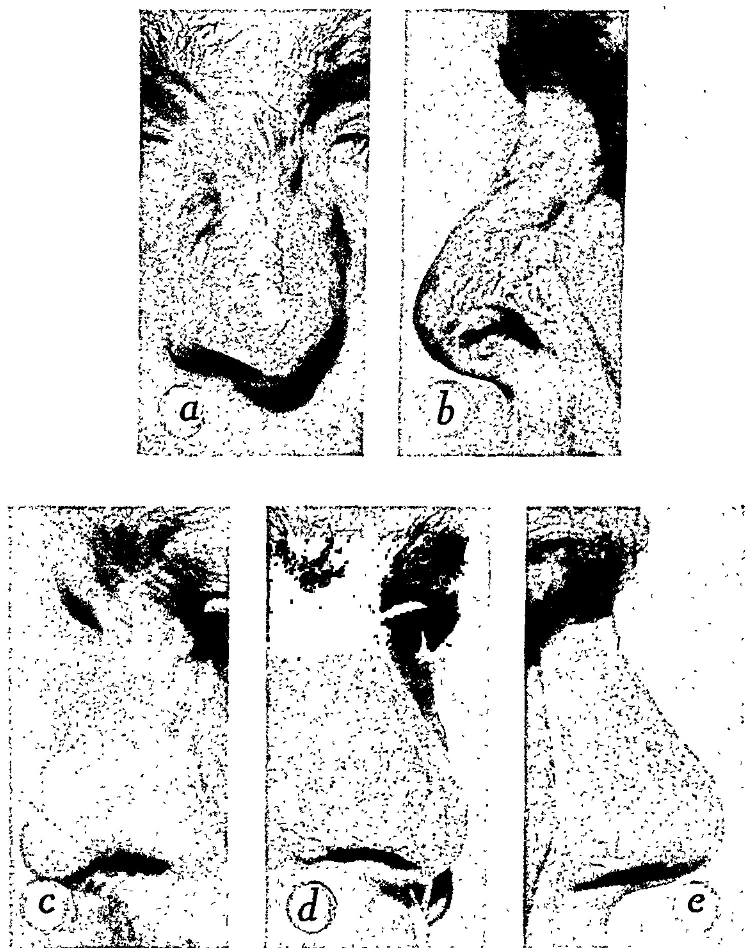


Fig. 118.—Destruction of nasal covering skin. *a* and *b*, Scar and distortion of left ala following third-degree burn; *c*, *d*, and *e*, appearance of nose after removal of scar and after covering with full-thickness skin from mesial surfaces of the ears.

two layers of gauze impregnated with scarlet red ointment. Several layers of gauze, a piece of moist, synthetic sponge about ½ inch (about 1.3 cm.) thick, and a cotton eye pad to cover the entire nose are added. A copper nasal splint is applied and fixed to the cheeks with a strip of adhesive tape (Fig. 61).

CHAPTER VI

BLEPHAROPLASTY

TRAUMA resulting from the many phases of warfare produces every conceivable type of damage to, and loss of, the eyelids, globe, orbital soft parts, nerve supplies, and the supporting framework of the structures named. The damage is produced by missiles of various types, violent collisions, and burns. The injuries, losses, and resulting disabilities have their counterparts in civil life, as the result of accidents of transportation and industry and as other mishaps. The injuries frequently are complicated by damage to neighboring soft tissue and bony framework, by loss of them, or by both.

It is not desirable to discuss the multitude of accidents but, rather, to describe basic principles and procedures which will permit the surgeon to devise a rational plan and to choose a sound procedure for repair which will result satisfactorily, both functionally and cosmetically. (For anesthetic procedures, see Section IV.)

PTOSIS

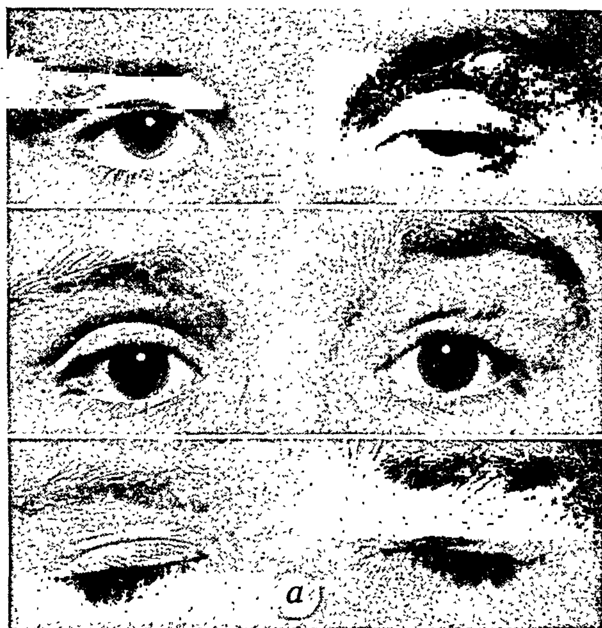
Types

Ptosis may be congenital or traumatic. *Congenital ptosis* can be broadly classified as follows: (1) existence of fair, independent levator action; (2) ptosis nearly complete, with little or no levator action, but with a functioning superior rectus muscle; (3) ptosis complete, with impaired or absent function of the superior rectus muscle. Most cases of congenital ptosis fall in Groups 1 and 2. *Traumatic ptosis* results from local or central injury. The disability may or may not include the superior rectus muscle.

Technics

The operative procedures, of which there are more than fifty, are of three types:

1. Shortening of the levator muscle and excision of skin and tarsus. This is useful only in Group 1 of congenital ptosis (Panas).





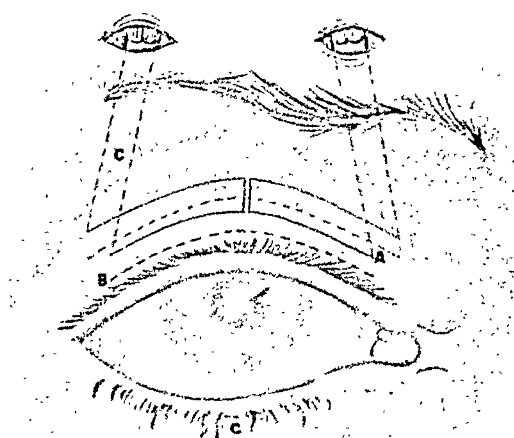


Fig. 119.

2. Attachment of the lid to the frontalis muscle.
   (*a*) Silk or linen stitches (Pagenstecher).
   (*b*) Flaps.
      (1) Skin and orbicularis oculi muscle (Maschek-Gifford).
      (2) Orbicularis oculi muscle only (Reese).
   (*c*) Fascial strips (Blair).
3. Employment of the superior rectus muscle to elevate the lid (Trainor; Motais; Greeve).

Maschek's Operation for Ptosis, Modified by S. R. Gifford

A horizontal incision, including skin and orbicularis oculi muscle, is made 6 mm. (3 mm., Gifford's) above the free margin of the lid and extends almost to the outer and inner canthi (Fig. 119, c). Gifford's incision stops 3 mm. short of each canthus to avoid resistance of the internal and external palpebral ligaments (Fig. 119, c). A second incision, slightly longer than the first, is made 5 mm. above it. In the moderate case, this incision is made 4 mm. above the first in order that the resultant skin fold will fall into the same plane as the normal. The higher the incision (wider flap), the greater the elevation obtained.

The rectangular flap formed by these incisions is cut in the middle, leaving it attached at each end (Fig. 119, c). The flaps are drawn in different directions to determine the best line of traction for the desired elevation. Tunnels through the brow and lid are made in the selected direction by blunt dissection through small incisions along the upper margin of the eyebrow. The epithelium is removed from the skin of the flaps by scraping and painting with trichloracetic acid. The flaps are drawn through the tunnels and fixed to the frontalis muscle with a stitch (Fig. 119).

A cone made from a cleaned roentgenographic film is placed over the eye and fixed to the skin with adhesive tape around its free edge. This should make an air-tight seal. Moisture collects in the cone and prevents drying of the cornea.

The *Reese* procedure departs from what has just been described

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Fig. 119.—Maschek-Gifford operation for unilateral or double ptosis. *a*, Appearance of a patient with unilateral ptosis before (uppermost photograph) and after (two lower photographs) operation; *b*, appearance of patient with bilateral ptosis before (upper photograph) and after (lower photograph) operation; final picture five years after operation; *c*, the curved, dotted lines, AB, locate Gifford's incision; the curved, solid lines outline Maschek's incision; the diagonal dotted lines, C, locate the general position of the supporting flaps which are sutured into the frontalis muscle.

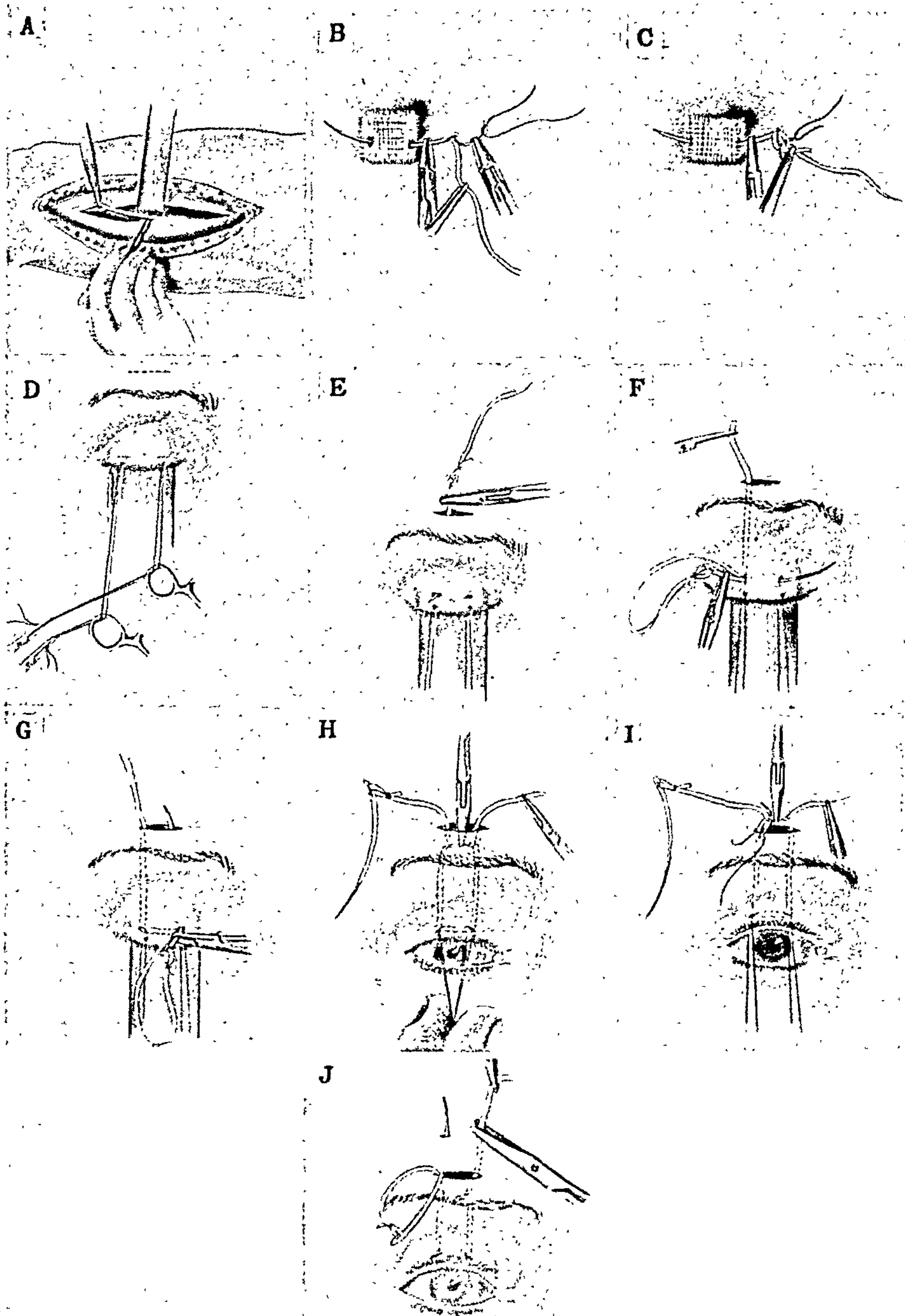


Fig. 120.—Ptosis. Support with implanted fascial strings. A, Cutting the fascial strips; this was the original procedure; fascia is now obtained with a Masson stripper; B and C, fixing the fascial thread in the carrier needle; D, traction sutures; dotted lines represent incisions in brow and lid; E, first insertion of the carrier needle; F, second insertion of carrier needle; the fascial strip is sutured to the tarsus with fine silk at this and the next insertion, to prevent

by inclusion of muscle only (no skin) and cutting of the ends of the flap so that it remains attached to, and elevates, the middle of the lid.

Operation for Ptosis of Blair, Brown, and Hamm

Some action of the occipitofrontalis muscle suggests attaching fascia to it.

Obtaining the Fascia.—The fascia is cut from the iliotibial band (Fig. 120, A). Clear away the fat until the longitudinal fibers are plainly seen. Incise along the anterior part of band for the desired length. Free the fascia from underlying muscle; protect with a spatula. With a *sharp knife* cut several strands 2 to 3 mm. wide and 1 to 15 cm. long. Close the fascia with catgut; the skin, with running suture. The fascia can be obtained better with a stripper (p. 23).

Fixing the Fascia Strip to a Needle.—A slender, curved needle, with a moderately large eye, is passed into a sterile, moist pad and held with needle forceps (Fig. 120, B). A second, fine, curved needle is threaded with silk, No. 000 (Fig. 120, B). The point of the fine needle, which is grasped with needle forceps, serves to push the fascial strip through the eye of the larger needle. The end drawn through the eye of the needle is fixed to the main strand with fine silk (Fig. 120, C).

Surgical Procedure.—Insert an eye protector beneath the lid. Fix and exert tension on the lid by passing two silk sutures through the inferior margin of the tarsus. Pass the threads through the rings of two ordinary, anchored hemostats and weight the threads with hemostats at their ends (Fig. 120, D). Make a transverse incision, 1 cm. long, through the scalp at the point of greatest action of the frontalis belly of the muscle (Fig. 120, D, E).

Two stab cuts, 1 cm. apart, are now made in the skin of the lid, in the crease that normally traverses it, slightly above the tarsal border. The midpoint of these two cuts should mark the highest elevation of the lid (Fig. 120, E). Pass the carrier needle subcutaneously from the outer angle of the upper incision, through the corresponding lower incision. Keep the fascial strand in a gauze sponge moistened with saline solution. *Guard against contamination* (Fig. 120, E). Reinsert the carrier so that it will engage the upper border of the tarsus and will emerge from the second cut (Fig. 120, F). *Guard the strip from contact with the eyelashes.*

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puckering when the strings are fixed on tension in the frontalis muscle; G, third insertion of carrier needle; fascia is fixed with silk at this point; H, single tension knot held with a hemostat; I, fixation of the knot with a silk stitch; J, insertion of fascial ends in frontalis muscle, burying the ends (Blair, V. P., Brown, J. B., and Hamm, W. G.: Arch. Ophth., June, 1932).

Blair now fixes the fascial string to the tarsus with a silk stitch passed through each of the incisions in the lid. This prevents puckering when the ends are tied into the frontalis muscle on tension.

Reinsert the carrier so that it will emerge from the inner angle of the incision in the scalp (Fig. 120, G). Relax the traction threads. Tie a single knot (twist) in the strands. This knot is drawn into the incision when the desired elevation of the lid is obtained. Fix the knot with a fine hemostat thrust into the depth (Fig. 120, H). Test the length and tension of the loop by traction on the silk threads while the forceps on the twist are so held as not to influence the tension. Fix the knot, after drawing it out of the wound, with fine silk sutures (Fig. 120, I). Pass the free ends of the strands beneath the scalp;



Fig. 121.—Unilateral ptosis before and after correction with fascial support (Blair).

draw them tense and cut them at the surface of the scalp. They will retract out of sight (Fig. 120, J).

Close incisions with fine interrupted sutures. Dress with cotton eye pads for twenty-four hours. Keep the eye covered with an air-tight cone until all reaction has subsided.

Fig. 121 represents the result that can be obtained by use of the operation which is the subject of Fig. 120.

Trainor's Operation for Ptosis

Results obtained with this operation are represented in Figs. 122, 123.

Procedure.—Evert the upper lid (Fig. 124, A). Make an incision 2 mm. deep at the junction of the outer third and fourth quarters of the lid. This incision is made perpendicular to the tarsal margin (Fig.

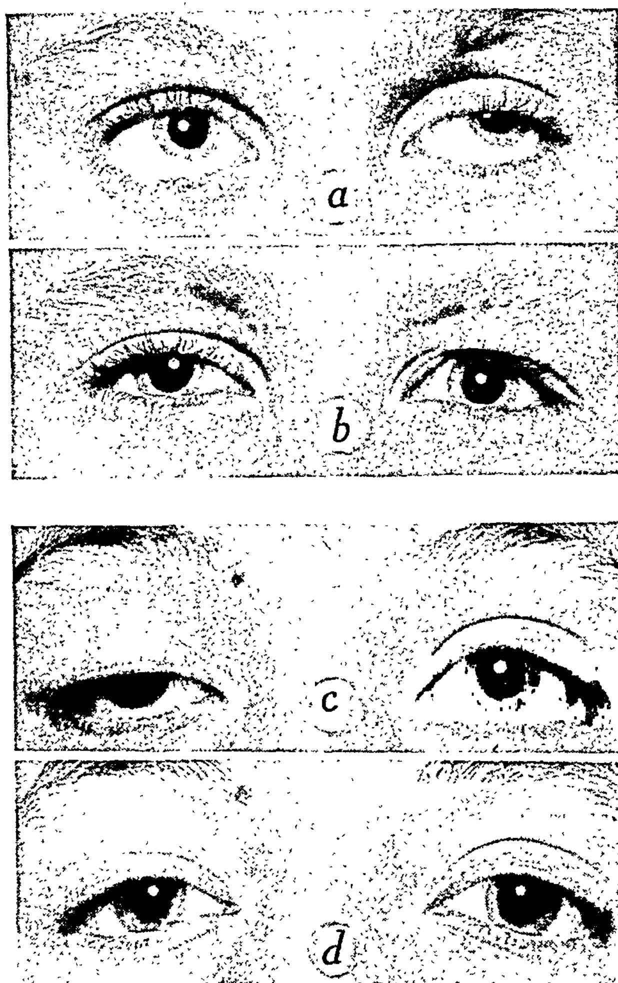


Fig. 122.—Ptosis (Trainor's procedure). *a*, Before and, *b*, after operation; this lid is slightly overcorrected; *c*, before and, *d*, after operation.

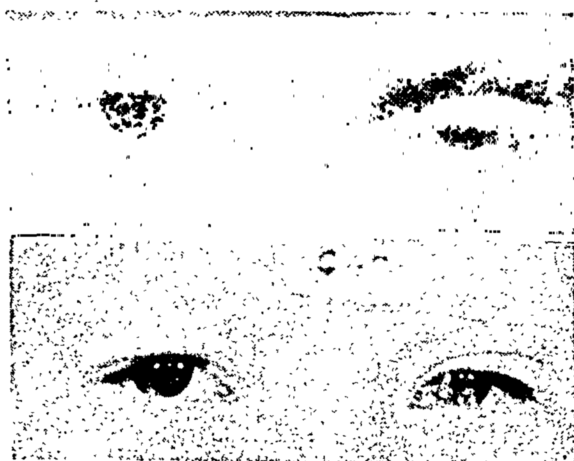


Fig. 123.—Unilateral ptosis. *Above*, before and, *below*, after correction (Trainor)

124, A). Turn the scissors and cut parallel to the tarsal margin for 7 to 10 mm. to the junction of the first and second quarters of the lid (Fig. 124, B). This makes a tongue of the fibrous plate, covered by conjunctiva on both sides. Make an incision on each side of the superior rectus muscle, leaving the conjunctival covering intact (Fig. 124, C). Insert a squint hook under the muscle. Pull the eye down. Enlarge the opening under the muscle to admit a small hemostat. Insert this hemostat from the temporal side. Grasp the tarsal tongue

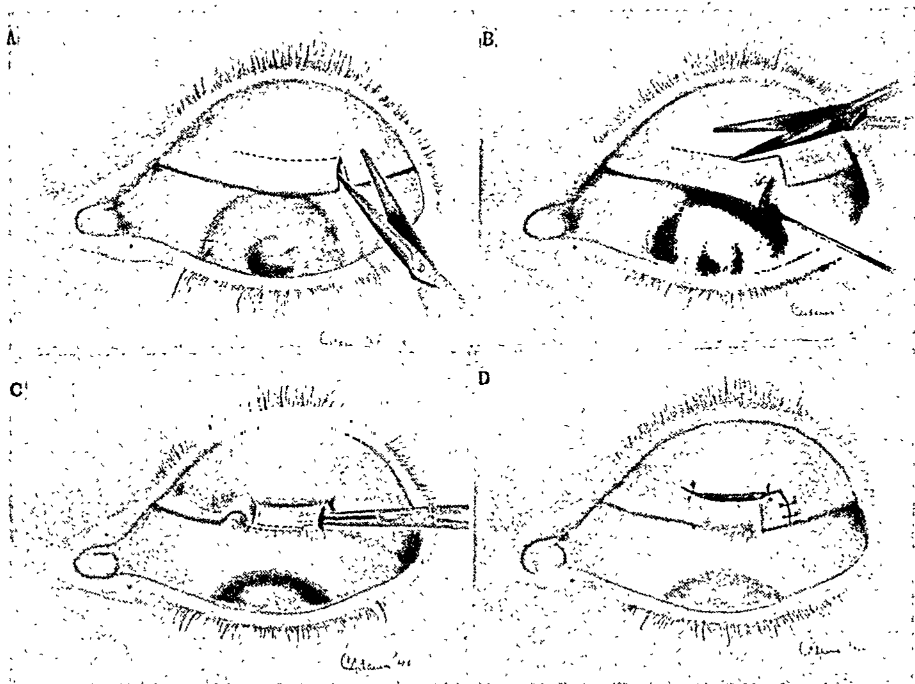


Fig. 124.—Ptosis. Trainor operation. A, Incision 2 mm. long, at a right angle to the superior border of the tarsal plate; B, incision extended parallel to the superior border of the tarsal plate; C, tongue-shaped flap, resulting from the incisions represented in A and B, being drawn under the superior rectus muscle; D, flap stitched in its original location.

and pull it under the superior rectus muscle. Stitch it in its original position with one fine silk suture (Fig. 124, D).

Turn the lid down in its normal position. It is frequently overcorrected. This can be adjusted by tension on the lid to pull it down or by everting the lid again and lengthening the tongue. A silk suture fixing the tongue to its original attachment on each side of the muscle tendon produces maximal elevation. Close the lids with one or two sutures and allow them to remain so for twenty-four to forty-eight hours. Trainor recommends that no dressing be applied.

EPICANTHUS

Epicanthus consists of a fold of skin covering the inner canthus to a greater or lesser degree. It may be of congenital or traumatic origin. The fold of skin is produced by the traction, or vertical shortness, of its free, rolled edge. Traumatic epicanthus results from local loss of tissue and scar contraction, or from a similar process in the eyelids. The condition may limit the movement of the upper lid to produce definite ptosis (Fig. 125, *top*).

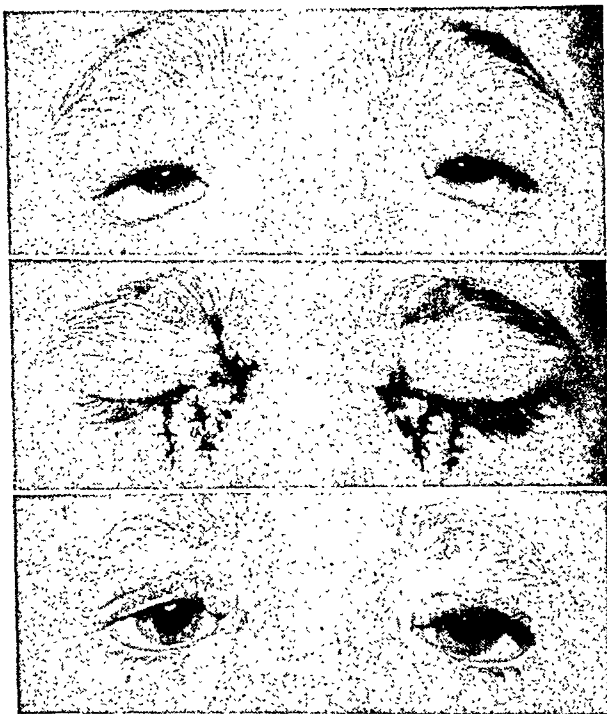


Fig. 125.—Mechanical ptosis and epicanthus caused by shortness of the lower lid. *Top,* extreme effort to elevate the lids; *middle,* lengthening of the lids with interpolated nasal skin flaps; *bottom,* result of lengthening of lids.

Correction is obtained by lengthening the vertical dimension at the expense of the redundant horizontal one. This is effected by Z plastic operations (Fig. 126), the shifting of various shaped flaps locally, or the interposition of new tissue, pedicle flaps, or free grafts.

"Mechanical" Ptosis and Epicanthus

The condition contemplated here results from shortness and narrowness of the lower lid. The condition pictured in Fig. 125 is congenital. It may be acquired by loss of substance of the lower lid.

Procedure.—Make an incision just lateral to the punctum to separate the conjunctiva along two-thirds the length of the lid. Incise the

skin and underlying tissue to the conjunctiva along a vertical line 2 or 3 mm. lateral to the punctum. A defect of V shape defines the size of the required addition. Cut a flap of desired dimensions from the lateral surface of the nose, mesial to the canthus. Transpose the flap. Approximate the flap and margins of the defect in the lid with interrupted sutures of horsehair. Close the defect in the nasal skin in a similar manner (Fig. 125, *middle*).

Note the strong traction of the frontalis muscles in Fig. 125, *top,* with residual ptosis and epicanthus. Contrast with Fig. 125, *bottom.*

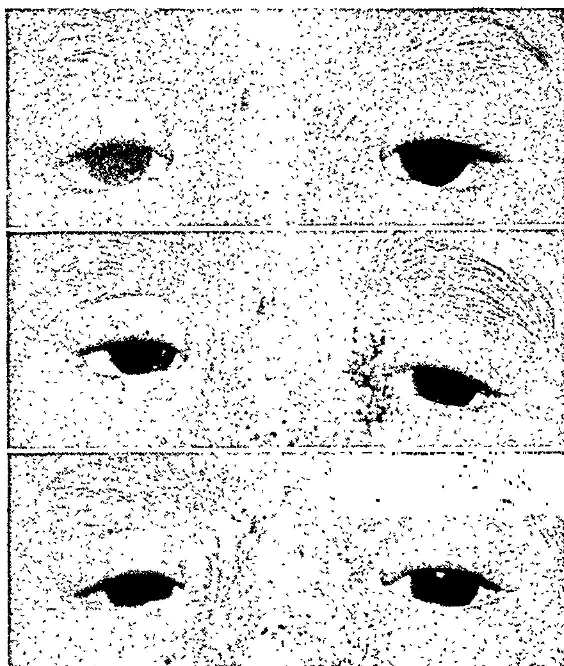


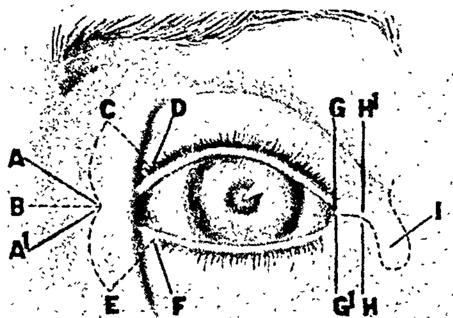
Fig. 126.—Bilateral ptosis; epicanthus. Correction of one side by Z plastic operation.

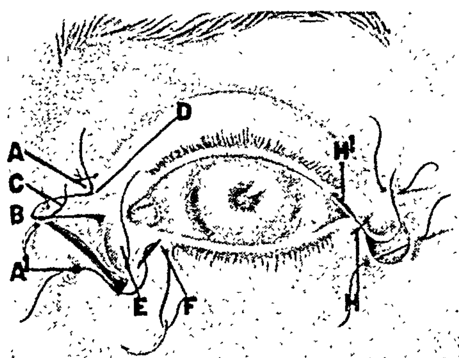
Correction of Epicanthus and Short Palpebral Fissure (Blair)

Procedure.—Make the horizontal incision, AB in Fig. 127, *upper* (the dotted lines represent the incisions; the heavy black lines indicate only the points where the letters apply). This incision is 8 mm. long and begins at a point 5 mm. from the canthus. The incision is carried down to the inner canthal ligament but not through it. Make incisions AC and A^1E, curving temporally both upward and downward from the starting point, A (5 mm. from the canthus). These incisions are 7 mm. long (Fig. 127, *upper*). From the terminations of these incisions (C and E) make incisions to points D and F on each lid, 4 mm. from the canthus (Fig. 127, *upper*). Dissect and

transpose the flaps thus described: C and E approximate B; A approximates D; A^1 approximates F. Close the approximating edges with interrupted sutures of horsehair.

Apply a cotton eye pad and strips of adhesive tape. Remove all stitches, except those at the nasal angles of the flaps, on the second day. Support with gauze strips applied with collodion.





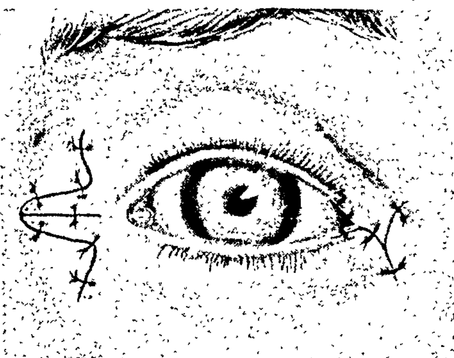


Fig. 127.—Epicanthus and short palpebral fissure. *Upper,* lines of incision for correction; *lower left,* disposition of flaps; points of suture; *lower right,* completion of the correction. Letters on the face of the drawing are explained in the text (Blair, V. P., Brown, J. B., and Hamm, W. G.: Arch. Ophth., June, 1932).

Canthoplasty

Procedure.—Make an incision beginning at the canthus (G and G^1 of Fig. 127, *upper*) and running laterally 3 or 4 mm., cutting the external canthal ligament, curving downward and outward for about 6 mm., and then curving upward to terminate about 7 mm. lateral to, and 5 mm. above, the canthus. Dissect the flap (Fig. 127, *upper,* I) but do not dissect the skin margin continuous with the lower lid.

Undermine the conjunctiva with scissors and stitch the conjunctiva with silk to the skin of the lower lid at the point of desired canthal opening, H of Fig. 127, *lower left.* Stitch the conjunctiva to upper lid further laterally than below to provide the relaxation of

the upper lid that will be necessary to permit its raising (note new location of H[1] in Fig. 127, *lower left*). Approximate the skin at the points of conjunctival attachment to form the new canthus. Close the approximated skin edges with interrupted horsehair sutures (Fig. 127, *lower right*). Dress as for correction of epicanthus and short palpebral fissure.

Von Ammon's Method.—The purpose here is to widen the palpebral fissure.

PROCEDURE.—Hold the outer commissure open with the thumb and finger. Push one blade of strong scissors into the outer cul-de-sac, as far as it will go. The blade must be *exactly* in the line of the closed palpebral fissure. Make a cut 10 to 15 mm. long. Divide the external canthal ligament. Make traction upward and inward on the margin

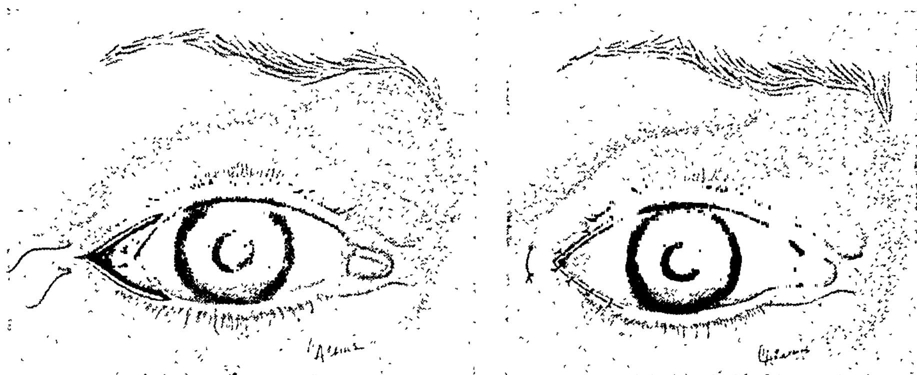


Fig. 128.—Canthoplasty (Von Ammon). *Left,* incision of skin and conjunctiva at external canthus. Location of a mattress fixation suture; *right,* final enlargement of palpebral fissure; cutaneous-conjunctival sutures.

of the upper lid to open the incision between the skin and conjunctiva and to cause tension of the ligament. Introduce the scissors and cut the ligament that is under tension at a right angle to the incision in the skin. Repeat this below. Pass a mattress suture below the angle of the conjunctiva and through the skin on each side of its angle (Fig. 128, *left*). Tie. Approximate the remainder of the conjunctiva and skin with interrupted silk sutures.

ECTROPION

Ectropion is an eversion of the margin of either the upper or the lower lid, or both. Ectropion of the lower lid causes epiphora and irritation of the exposed conjunctiva; ectropion of the upper lid results in lagophthalmos which, if marked, may lead to loss of the eye.

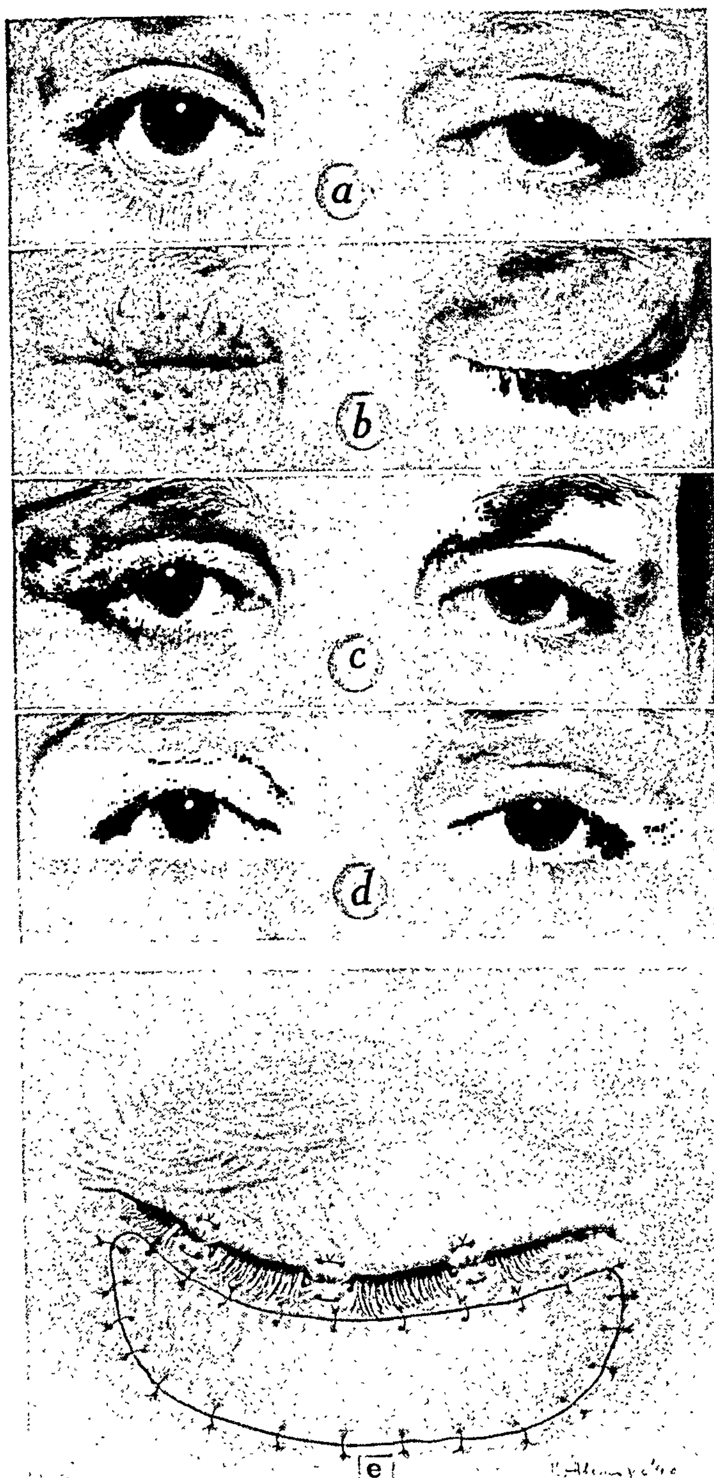


Fig. 129.—Ectropion of the lower lid (Wheeler). *a,* Condition (eye open) before correction; *b,* appearance on first removal of dressing (twelve days); skin graft taken from the upper lid, used to cover lower lid; horsehair sutures in upper lid; surgical adhesion; *c,* appearance sixty days after operation; surgical adhesion between the lids; *d,* result one year after operation; *e,* adjacent raw surfaces of the upper and lower lids approximated with horizontal horsehair sutures to produce surgical adhesions; skin graft on lower lid; simple suture.

Types

The ectropion of military surgery is either cicatricial or paralytic in origin. The *cicatricial* type results from loss of tissue and the sub-

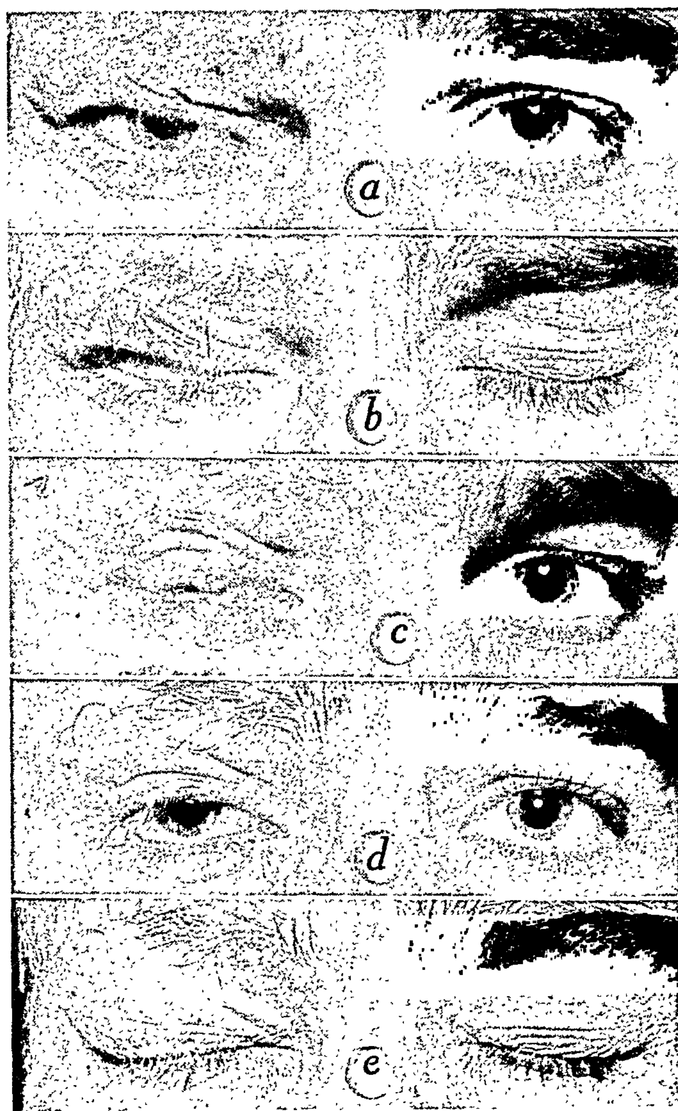


Fig. 130.—Ectropion of the upper lid. *a*, Eyes open; *b*, eyes closed; *c*, eyes open thirty days after repair with a full-thickness graft taken from the back of the ear; surgical adhesions fixing the lids; *d* and *e*, four months later, eyes open and eyes closed.

sequent scar contraction. The *paralytic* type results from paralysis of the orbicularis muscle (seventh cranial nerve). It begins with slight eversion of the margin of the lid, which finally sinks of its own weight as the muscle degenerates from disuse. It is ultimately accentuated by

chronic catarrh and the disposition of the muscle below the inferior border of the tarsus.

Methods

Several satisfactory procedures are available for correction of cicatricial ectropion. The most satisfactory results, judged from all standpoints, result from (1) replacement of the lost tissue with a rotated flap from either the nasal or the temporal border of the lid or (2) correction of the defect caused by the loss of tissue either with full-thickness skin removed from a normal lid, or with skin from the mesial surface of the ear. This skin is utilized according to the technic of Wheeler. The epithelial outlay (Esser) does not produce so pleasing a cosmetic result as the procedure just mentioned.

Full-Thickness Skin Graft for Ectropion (Wheeler's Technic)

Procedure. STAGE 1.—Make an incision about 3 mm. from the margin of the lid from a point slightly outside the canthus on one side to a similar point on the other. Dissect the conjunctiva free until the lid lies at its normal level. Undermine the bordering scar until the skin lies without tension. Pare the epithelial surface from the margins of the lid at opposing points in the middle of the lids and at the junction of their outer and inner first and second quarters, for a length of 3 mm. (Fig. 129, *e*). Pass horizontal mattress sutures of silk through the two lids in a manner to approximate these raw surfaces (Fig. 129, *e*). Tie the sutures sufficiently tight to approximate the lids gently and at the same time to make allowance for subsequent swelling without cutting. A small block from the wall of a rubber tube can be placed under these sutures as they cross the skin to prevent cutting, but this is unnecessary if proper care is exercised in tying them.

Make a pattern of the defect in the skin. Excise full-thickness skin of this exact pattern from a normal upper lid, if size permits, or from the skin on the mesial surface of the ear (Fig. 129, *b*, *e*). Approximate the edges of the graft to the edges of the defect with interrupted sutures of fine horsehair (Fig. 129, *b*, *e*). Tie the sutures lightly but sufficiently to approximate the edges.

Instil boric acid ointment beneath the lids. Cover with a cotton eye pad and fluff gauze. Apply a firm bandage and supplement this with strips of adhesive tape. This dressing should remain unopened for twelve days (pp. 55 to 60).

STAGE 2.—An interval of twelve days is allowed to elapse between Stages 1 and 2. Open the dressing, remove the stitches, and

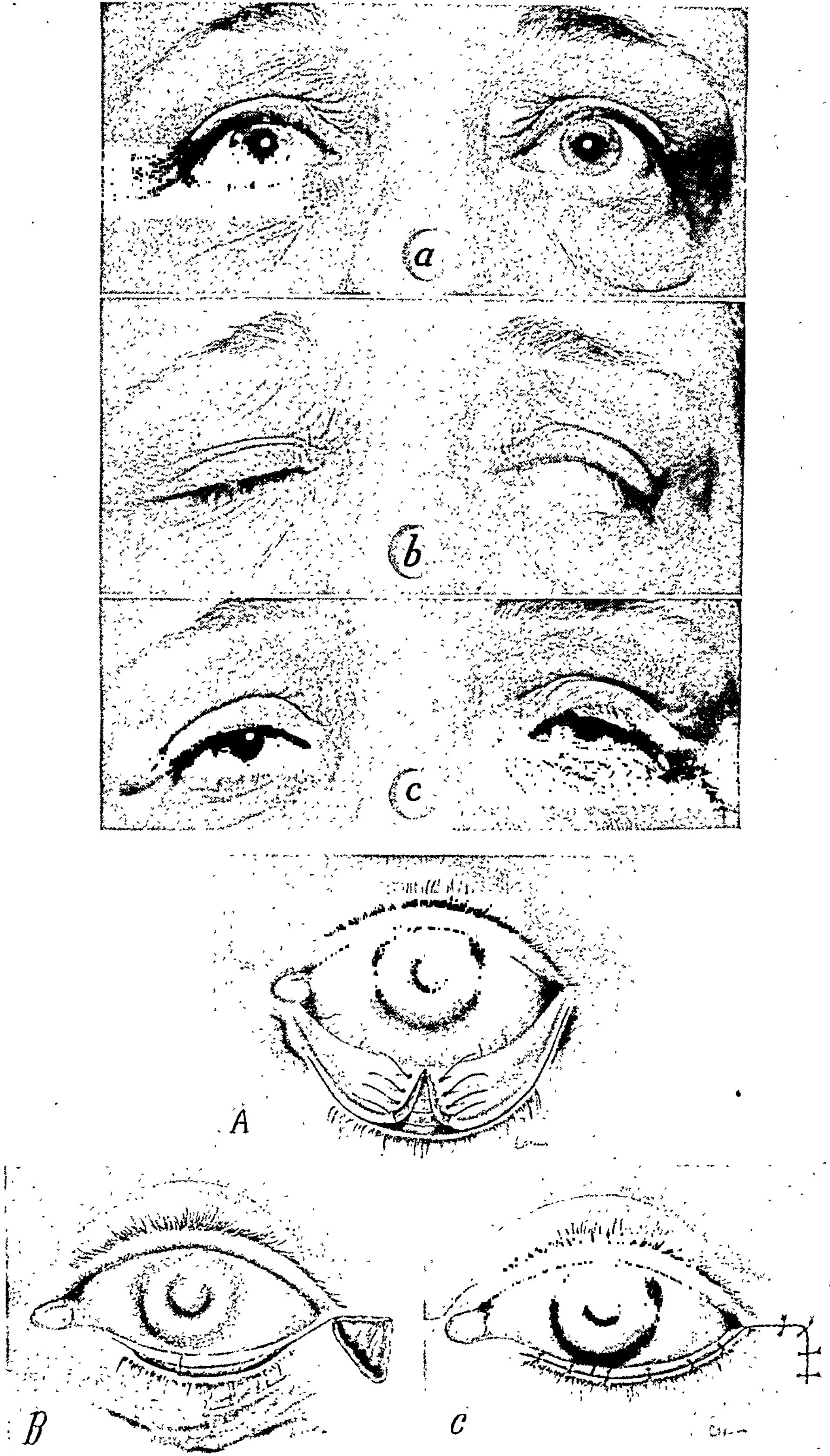


Fig. 131.

again apply a dressing under moderate pressure at intervals for several days. The support of this dressing aids materially in the safe growth of the graft for several days subsequent to opening the original dressing.

The surgical adhesions between the lids remain for sixty to ninety days, or longer, depending on conditions. Complete organization of scar never occurs sooner than six weeks and frequently requires a longer period. The surgical adhesions may be so disposed in certain cases to permit some vision through the central portion of the lids (*Cp.* Figs. 129, c, 130, c).

Paralytic Atrophic Ectropion (Palsy of Seventh Cranial Nerve)

The following procedure removes the redundancy of the lower lid and furnishes a fixed mechanical support in those cases wherein it has been impossible to restore function of the nerve.

Procedure.—Make an incision on the conjunctival surface of the lid, beginning at a point 2 mm. lateral to the punctum and extending to the opposite canthus, to separate the skin from the underlying tissues. This incision should avoid the follicles of the eyelashes (Fig. 131, A). Remove a wedge-shaped piece of "musculotarsoconjunctival" layer of sufficient size to put the conjunctiva under tension and to hold it firmly against the globe (Fig. 131, A). Close the defect with several interrupted sutures of fine silk (Fig. 131, A).

Obtain a strip of fascia lata 2 mm. wide and 15 to 20 cm. long as described on page 23. Pass this about the lids and fix it in the temporal muscle for permanent support, as described on page 133 (Fig. 85, *top*). Make a right-angled incision through the skin at the outer canthus, as pictured in Fig. 131, B. Make lateral traction on the skin of the lid until it snugly approximates the lining layer. Remove the excess skin and approximate the opposing edges as pictured in Fig. 131, C.

Close the lids by applying several strips of fine-mesh gauze across them and fixing them with collodion. Instil boric acid ointment beneath the lids. Apply a cotton eye pad, fluff gauze, and a firm bandage. This dressing pressure should be maintained for several days until the reaction to the implanted fascial strip has subsided.

Fig. 131.—Paralytic ectropion. *a* and *b,* Condition before operation, with eyes open and closed; c, condition six days following operation; A, Kuhndt procedure; separation of skin from underlying tissues; removal of a suitable wedge from the musculoconjunctival layers; sutures placed; B, musculoconjunctival layer closed with fine silk sutures; triangular excision of skin to remove excess skin of lid; C, final repair.

ENTROPION

Types

This condition may be of spastic or contractile origin. The *spastic* variety results from spasm of the orbicularis oculi muscle. Any condition which causes pressure of the lid against the eyeball is an aggravating factor (bandage pressure, blepharophimosis, and so forth). Contraction of the subtarsal muscle turns the edge of the lid inward so that the lashes irritate the cornea. *Cicatricial* entropion results from any condition which produces deep scar in the tarsus and conjunctiva and its subsequent contraction (burns, trauma, and so on). The tarsus is bent at a sharp angle.

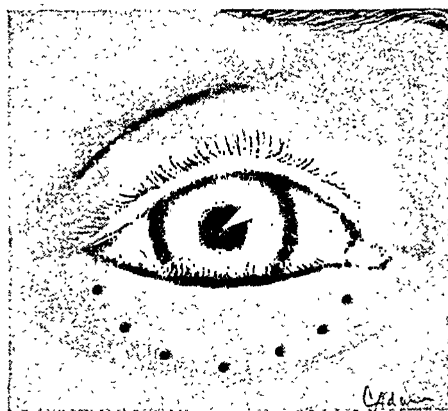


Fig. 132.—Entropion. Location of points of cauterization.

Spastic Entropion

A method of cauterization described by Ziegler is an efficient and simple way to relieve this condition immediately. Scar is created to hold the skin to the bottom of the tarsus. This causes the contraction of the orbicularis muscle to press the lower border of the tarsus against the globe rather than to pull the tarsus up and outward to evert the margin of the lid.

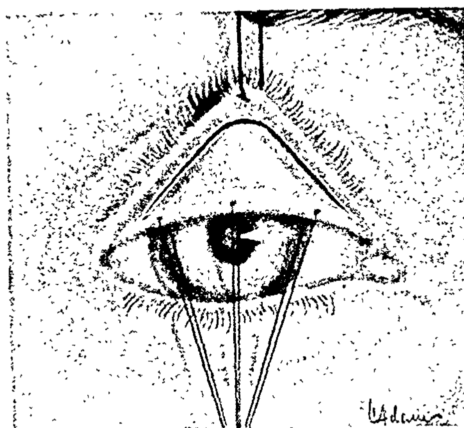
Procedure.—A local anesthetic agent is injected under the skin along the entire length of the lid. An assistant holds the patient's head against him and pulls the lid down by making firm traction on the cheek below it.

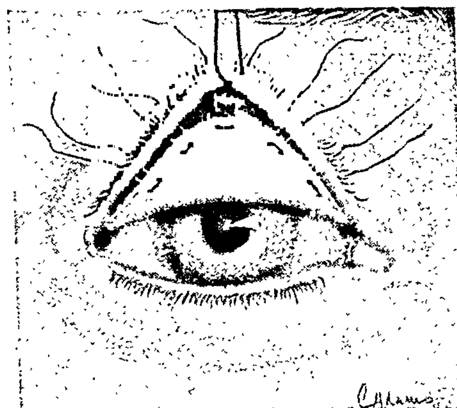
Insert a bone spatula behind the lid to protect the eye. An electric cautery point, heated to a red glow, is used to puncture the skin and subcutaneous tissue to a depth of 3 mm. at the midpoint of the lid, about 8 mm. below its margin. Other punctures are made on both sides of the first one (Fig. 132), each approaching nearer to the margin of the lid. They should mark a line a little below the lower

border of the tarsus. Apply compresses to control the swelling. No dressing is necessary.

Cicatricial Entropion

Numerous corrective procedures have been described. Two of them seem to produce the best results if excessive loss of conjunctiva has not taken place.





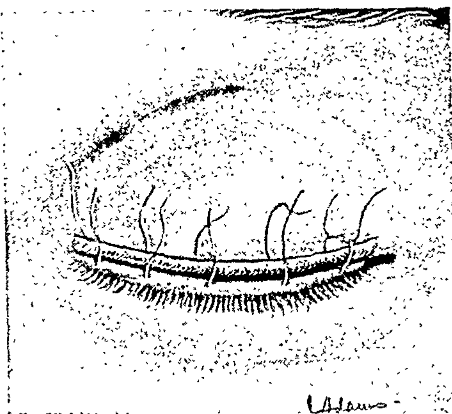


Fig. 133.—Contractile entropion. *Upper,* traction stitches in the margins of the lid and tarsal plate; line of incision through the conjunctiva and tarsus to the skin; *lower left,* mattress sutures through the conjunctival edge, covering the tarsus and the skin above the cilia; *lower right,* mattress sutures tied over a piece of heavy, braided silk to evert the margin of the lid (after Wiener and Alvis: Surgery of the Eye).

Wiener's Method.—This procedure is applicable in all cases in which the lower lid is affected and in cases in which the upper lid is affected if there is considerable narrowing of the tarsus.

PROCEDURE.—Instil one or two drops of solution of *cocaine* to anesthetize the eye. Evert the lid and balloon the retrotarsal fold with solution of *procaine* to which *epinephrine* has been added. Inject this solution also between the tarsus and the skin.

Pass four traction sutures. One is placed at the midpoint of the margin of the lid so as to include the edge of the tarsus, one at the midpoint of the superior edge of the tarsus, and one at each side, through the edge of the tarsus (Fig. 133, *upper*).

Incise through the conjunctiva and tarsus *to* the skin along the whole length of the tarsus and about 1.5 mm. from the margin of the lid (Fig. 133, *upper*). Pass five horizontal mattress sutures from the conjunctival edge farthest from the margin of the lid through the skin just above the cilia (Fig. 133, *lower left*). Remove the traction sutures and turn the lid down. Lay a piece of heavy, braided silk between the mattress sutures and tie loosely the first part of the knot. Stop any oozing by sponge pressure. Tie the sutures permanently (Fig. 133, *lower right*). Apply a light dressing and continue to employ it for twenty-four to forty-eight hours.

Hotz's Method.—Select a clamp that will include the entire length of tarsus, will protect the eyeball, and will control bleeding.

PROCEDURE.—Make an incision *through the skin* the entire length of the lid, which is parallel to, and about 2 mm. above, the margin of the lid (Fig. 134, *a*). Dissect the skin from the underlying orbicularis muscle to the upper border of the tarsus. Dissect the skin of the lower flap from the underlying soft tissues. Traction upward by a sharp hook in the tarsus facilitates the dissection by outlining its lower border. Keep the knife close to the surface of the tarsus. Avoid "buttonholing" the conjunctiva. Avoid the hair follicles; keep them with the lower flap (Fig. 134, *a*). This step in the procedure requires care and patience.

Incise through the fascia and orbicularis muscle around the borders of the tarsus. This incision is carried to the tarsus (Fig. 134, *b*). Grasp the muscle and fascia with flat tissue forceps and strip them from the tarsus. This is readily accomplished, to leave a white, smooth surface over the length of the lid (Fig. 134, *c*). The upper and lower borders must be clearly visible.

Make an incision with a sharp knife 1 mm. above, and parallel to, the lower margin of the tarsus. This incision is kept in the substance of the tarsus in order to avoid damage to the conjunctiva (Fig. 134, *d*). Grasp the tarsus at one end of this incision and complete the incision with sharp scissors (Fig. 134, *d*). This narrowing of the tarsal plate allows the margin of the lid and the lashes to become everted around this edge without undue tension on the stitches. This is the method of choice in the presence of a wide tarsus.

Pass five silk sutures in the following manner: Use a full, curved, cutting needle. Pass the stitch through the middle of the lower skin

flap. Elevate the upper border of the tarsus with a sharp hook and pass the needle so as to include 1 mm. of this edge. Pass the needle through the margin of the upper flap (Fig. 134, *e*). Tie the first half in a knot. Repeat this procedure with two stitches on each side of the first one.

Remove the clamp. Control bleeding by firm pressure with a gauze sponge. Pull the stitches with moderate firmness. The stitches must be pulled sufficiently tight to evert the margin of the lid and the

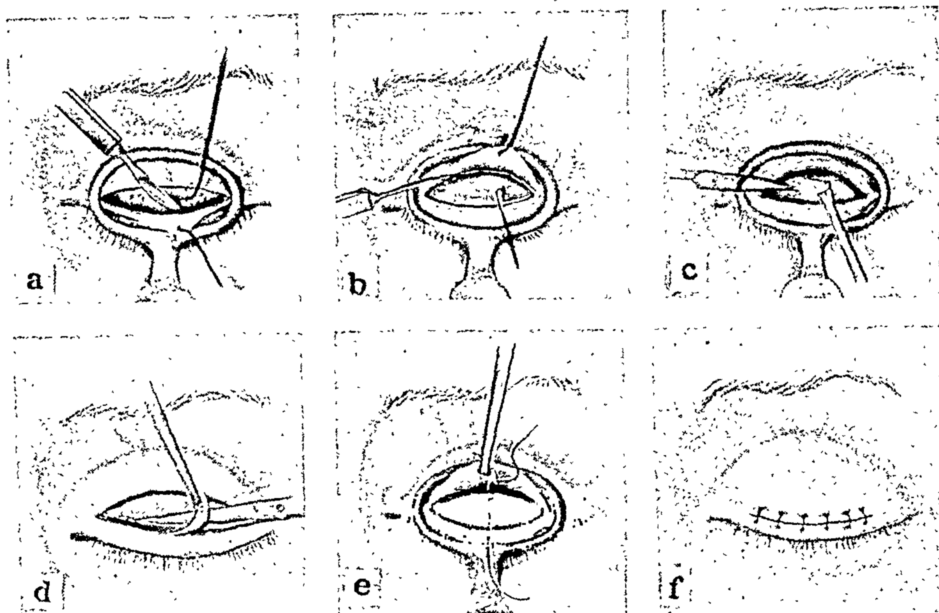


Fig. 134.—Contractile entropion (Hotz). *a*, Incision in skin along lower border of tarsus, above hair follicles; *b*, skin flap retracted upward and tarsus downward; an incision is carried through the fascia and orbicularis muscle, along the upper and lower borders of the tarsus; c, the fascia and orbicularis covering the tarsal plate are dissected off with scissors; *d*, an incision has been made in the tarsus 1.5 mm. above its border; the outlined tarsal strip is removed with sharp scissors; *e*, a silk stitch is passed through the skin at its midpoint, through the upper edge of the tarsus and through the skin of the upper flap at its midpoint; four similar sutures are passed, two on each side of this first suture; *f*, sutures tied to effect eversion of the margin of the lid (after Wiener and Alvis: Surgery of the Eye).

lashes. Tie the permanent knots. Employ an eye pad and a moderately firm bandage for twenty-four hours (Fig. 134, *f*).

A wedge-shaped strip, base anterior, should be excised also from the entire tarsus, if the cicatricial deformity is marked (Streatfield).

PARTIAL LOSS AT EITHER CANTHUS

In the condition under consideration here, the loss is of skin, tarsus, and conjunctiva.

Requirements

Skin and conjunctiva.

Procedure

Stage 1.—Outline and dissect a skin flap of the required size from the upper lid, with its base lateral to the canthus. Obtain conjunc-

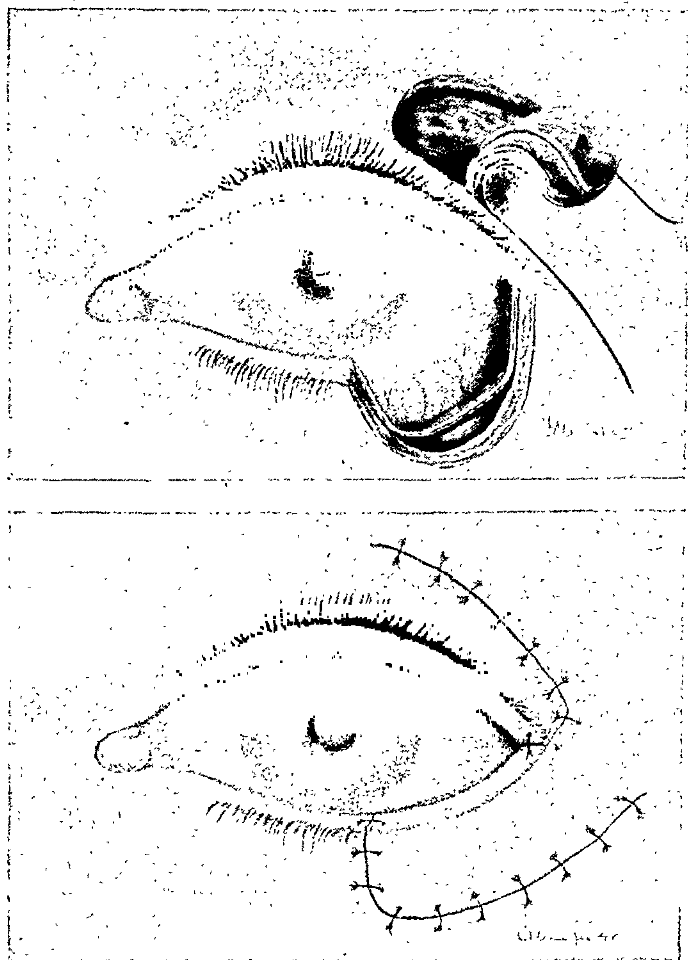


Fig. 135.—Partial loss of outer third of lid. Correction with a grafted, interpolated flap. *Above,* flap partially dissected and grafted with buccal mucous membrane; *below,* flap transposed; repair completed.

tiva, the exact size of the defect, from another lid (depending on the size) or material from the buccal mucosa. Suture this to the raw surface of the distal end of the flap (Fig. 135, *above*) and to its superior raw edge. Suture the margins of the flap with a few interrupted horsehair sutures. Delay for growth of graft and blood supply. Apply a cotton eye pad and firm gauze dressing; continue their use for twelve days.

Stage 2.—An interval of fifteen days passes between Stages 1 and 2.

Split the conjunctiva from the skin and the margins of the defect (Fig. 135). Elevate and rotate the flap. Suture the conjunctival or mucosal tissue on the flap to the borders of the conjunctival defect with interrupted silk sutures. Approximate all skin borders with interrupted horsehair sutures (Fig. 135). Remove the skin sutures in two days and support with gauze strips applied with collodion.

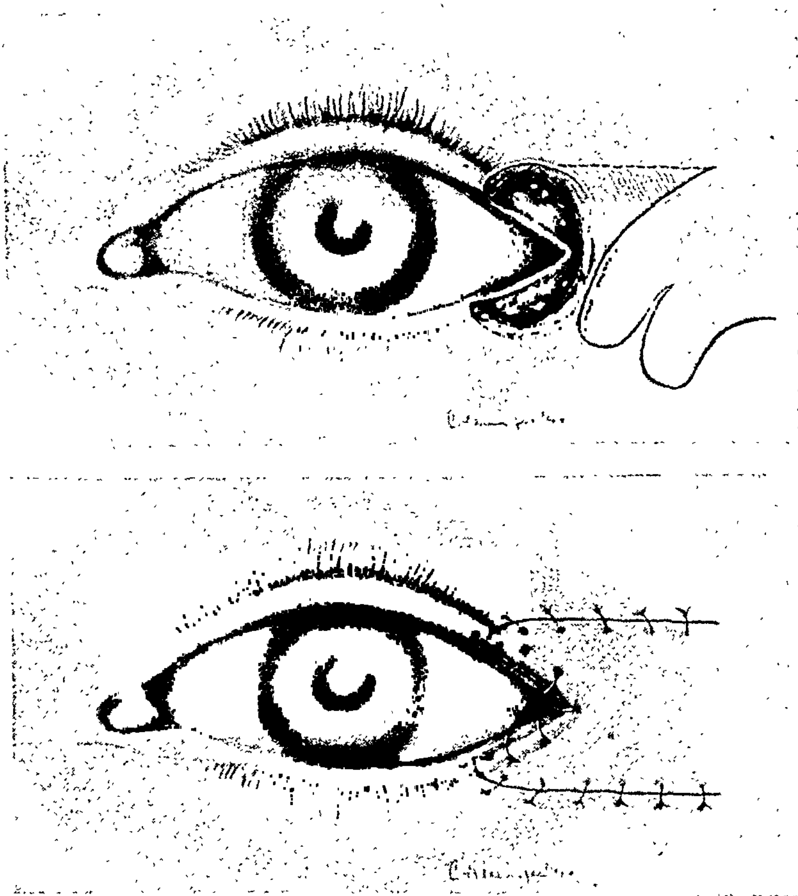


Fig. 136.—Loss of skin about outer canthus. Simple rotated flap.

Another Treatment for Partial Loss at the Canthi

The type of flap represented in Fig. 136 is an example of several flaps for this purpose which can be based on either the malar or the glabellar region, as the case requires. It is a simple, shaped, rotation flap comprised of skin and superficial fat.

PARTIAL LOSS OF LID

Under consideration here is reconstruction for a large partial loss, with tissues from the locality.

Loss

All elements of half of the lid.

Requirements

Skin, tarsus, muscle, and conjunctiva.



Fig. 137.—*Above,* carcinoma of upper lid; *middle,* condition of lid, eyes open, after reconstruction; *below,* condition of lid, eyes closed, after reconstruction.

Procedure

A case in point is represented in Fig. 137, and the flaps employed are outlined in Fig. 138, *a*.

Make an incision in the conjunctiva, 1 mm. from the margin of the lid. This will separate the skin and the underlying tissue from the edge of the defect to a point near the caruncle. Avoid hair follicles of the lashes. Make a parallel incision through the skin around the upper rim of the orbit (Fig. 138, *a*). Dissect skin flap A (Fig. 138, *b*). Separate the *skin* of the lower lid (Fig. 138, *a, b*). Make an incision between C and D (Fig. 138, *b*), at a point which will free a flap, C,

having sufficient length when rotated that its distal edge will approximate the conjunctival defect of the upper lid (Fig. 138, *b, c*). Pass two or three interrupted silk sutures.

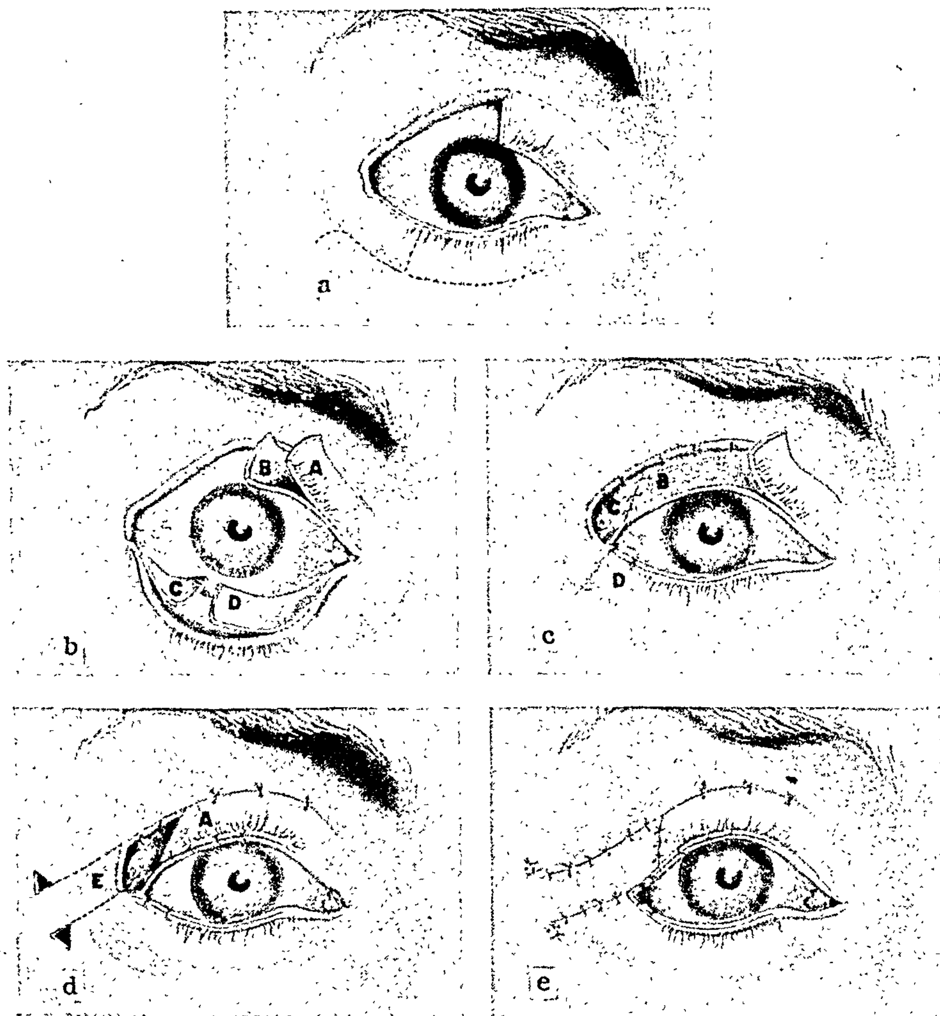


Fig. 138.—Loss of half of upper lid. *a,* Outline of incisions to separate skin from underlying tissues of both lids and to free musculoconjunctival flaps on lower lid; *b,* skin flap, A, separated from "musculotarsoconjunctival" flap B; separation of similar flaps, C and D, on lower lid; c, rotation and suture of distal end of flap C to conjunctival border of defect; suture of flaps B and D to mesial border of flap C; *d,* skin flap A is slid to the left and sutured; flap E is slid mesially to close the defect; e, result of the surface repair.

Incise the tarsal conjunctival flap, B, along the upper orbital rim sufficiently to allow its lateral edge to approximate the lateral edge of flap C. Fix these edges with two or three fine silk sutures, passed from within outward. Approximate the superior edge of the flap with interrupted catgut sutures (Fig. 138, *c*). Free the flap D (Fig. 138, *b*)

along the fornix sufficiently to permit its lateral edge to approximate the lateral edge of flap C (Fig. 138, c). Fix with interrupted silk sutures.

Approximate the superior edges of the skin and conjunctiva of the lower lid with interrupted silk sutures (Fig. 138, c). Draw flap A as far laterally as possible and fix with interrupted horsehair sutures

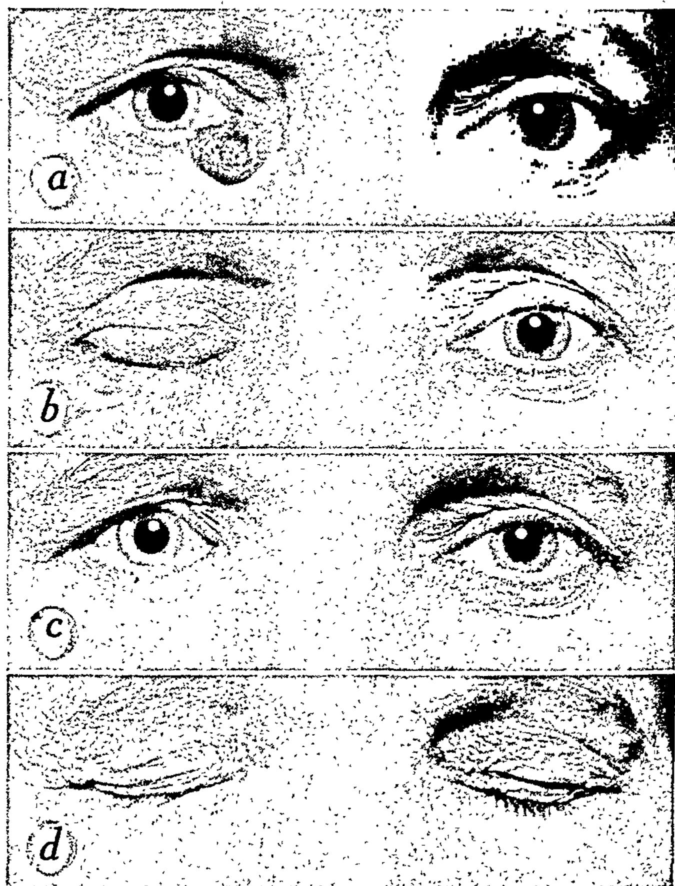


Fig. 139.—*a*, Carcinoma of lower lid; *b*, reconstruction of mesial half of lower lid (see Fig. 146); *c*, condition of the lid, eyes open, after reconstruction; *d*, condition of the lid, eyes closed, after reconstruction.

to skin above, and with silk sutures to conjunctiva below (Fig. 138, *d*). Outline, elevate, and approximate flap E with horsehair sutures (Fig. 138, *e*).

Instil boric acid ointment. Cover with a cotton eye pad and loose gauze. Apply a moderately firm bandage and continue it in use for forty-eight hours. Remove all skin stitches in two days and support with strips of gauze applied with collodion.

Example

Another relevant case is represented in Fig. 139.

Another Treatment for Partial Loss of Lid

The method contemplated here is reconstruction with a prepared flap from the border of the defect (Imrie). This type of flap is one of a variety of ingeniously designed flaps, either single or multiple, obtained from the vicinity of the defect. Lining tissue is provided by

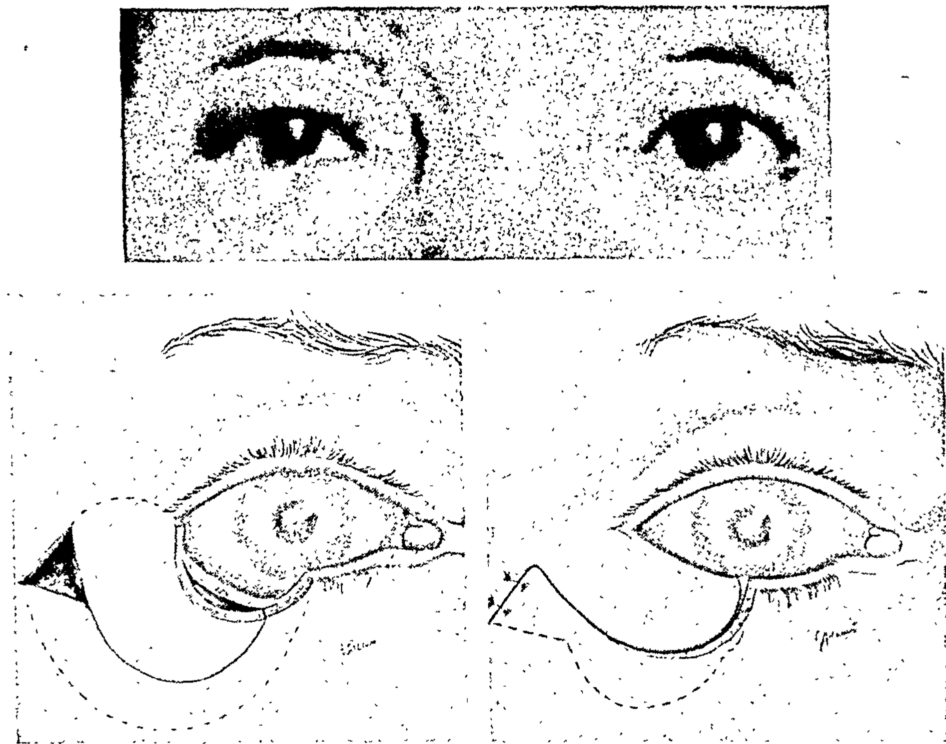


Fig. 140.—Reconstruction by the Imrie method for partial loss of the lower lid. *Top,* result of the reconstruction; *lower left,* skin flap grafted with mucous membrane to replace conjunctival loss; *lower right,* flap slid and sutured in position.

grafting wherever this is required (Figs. 140, 141). These flaps have the *disadvantage* of adding visible scar to the existing cosmetic defect. This disadvantage must, in some instances, be weighed against the time required for some other types of repair and the desirability of early return of the casualty to duty.

Procedure.—A flap of desired size and shape is outlined and elevated. If lining tissue is required, this is applied as pictured in Fig. 141, c. The graft is not only fixed with sutures to the raw surface of the flap in a proper location, but continued over the superior raw

edge of the flap. The flap is replaced in its bed and dressed with proper pressure for seven to twelve days. The time of this dressing is determined by the type of graft. The pressure on the thick, split graft can be released from five to eight days after its application, whereas

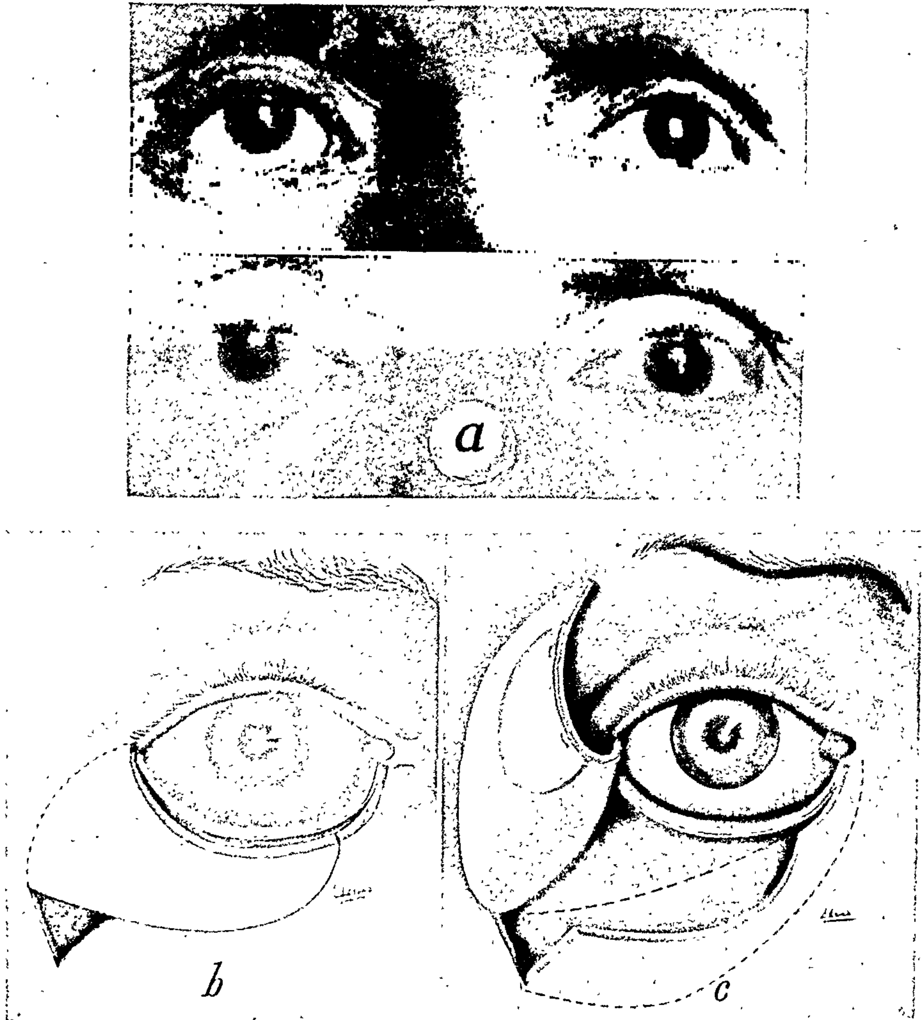


Fig. 141.—Large loss of the lower lid. *a*, Condition of lid before and after reconstruction; *c*, mucous-membrane graft on a dissected skin flap; *b*, flap slid and fixed in position.

the pressure on the full-thickness graft should remain for a period of twelve days (p. 55).

The flap is raised at a second stage after the above interval of time; the tissue bordering its base and inferior margin is freely undercut and the flap slid into place. The defect resulting from movement of the flap is closed with interrupted sutures after sliding and adjustment of the bordering tissues.

TOTAL LOSS OF LOWER LID

METHOD I

There are several useful methods of replacing this lost tissue. The procedure of Dupuy Dutemps is the method of choice, inasmuch as it not only provides all of the normal constituents of the lid, but produces the most satisfactory end-result from both functional and cosmetic standpoints.

The procedure described below, however, shortens materially the time required for repair. It can be completed in one major and one minor stage. Unless, however, the period following completion of the first stage is sufficiently long, the tissue of the region of reconstruction will contract during its late organization, and this will result in a less perfect lid than is obtained by the Dupuy Dutemps technic.

The loss contemplated here is of the entire lower lid and soft parts in the infra-orbital region beneath the orbital margin.

Requirements

Covering skin, tarsal support, and conjunctival lining.

Procedure

A tunneled flap is employed.

Stage 1.—Obliterate the infra-orbital defect by freely undercutting the bordering skin and underlying fat and sliding the skin toward the infra-orbital margin. Fix the skin in this position with several interrupted catgut sutures (Fig. 146, 6D). Pass a stout traction suture through the margin of the tarsus at the middle of the lid and a similar suture on each side near the canthi. Place a metal spatula beneath the lid and excise flap A (Fig. 142), of proper size to fill the defect, from the full thickness of the lid. Extend the superior and inferior incisions laterally to outline a proper pedicle and base for the flap.

Undermine the skin and subcutaneous tissue from the border of the defect to the base of flap B (Fig. 142). Draw the pedicle flap through the skin tunnel into the defect. Approximate the conjunctiva around the mesial and inferior borders of the defect with interrupted sutures of fine silk. Approximate the skin with interrupted sutures of horsehair. Approximate the borders of the conjunctival defect in the upper lid with interrupted sutures of fine silk and the muscular and cutaneous layer with interrupted sutures of horsehair. Pare the margin of the lid at its midpoint and at the junction of its inner and second quarters sufficiently to create a surgical adhesion with a raw margin of the transposed flap. Approximate these portions with mattress sutures (Fig. 129, *e*).

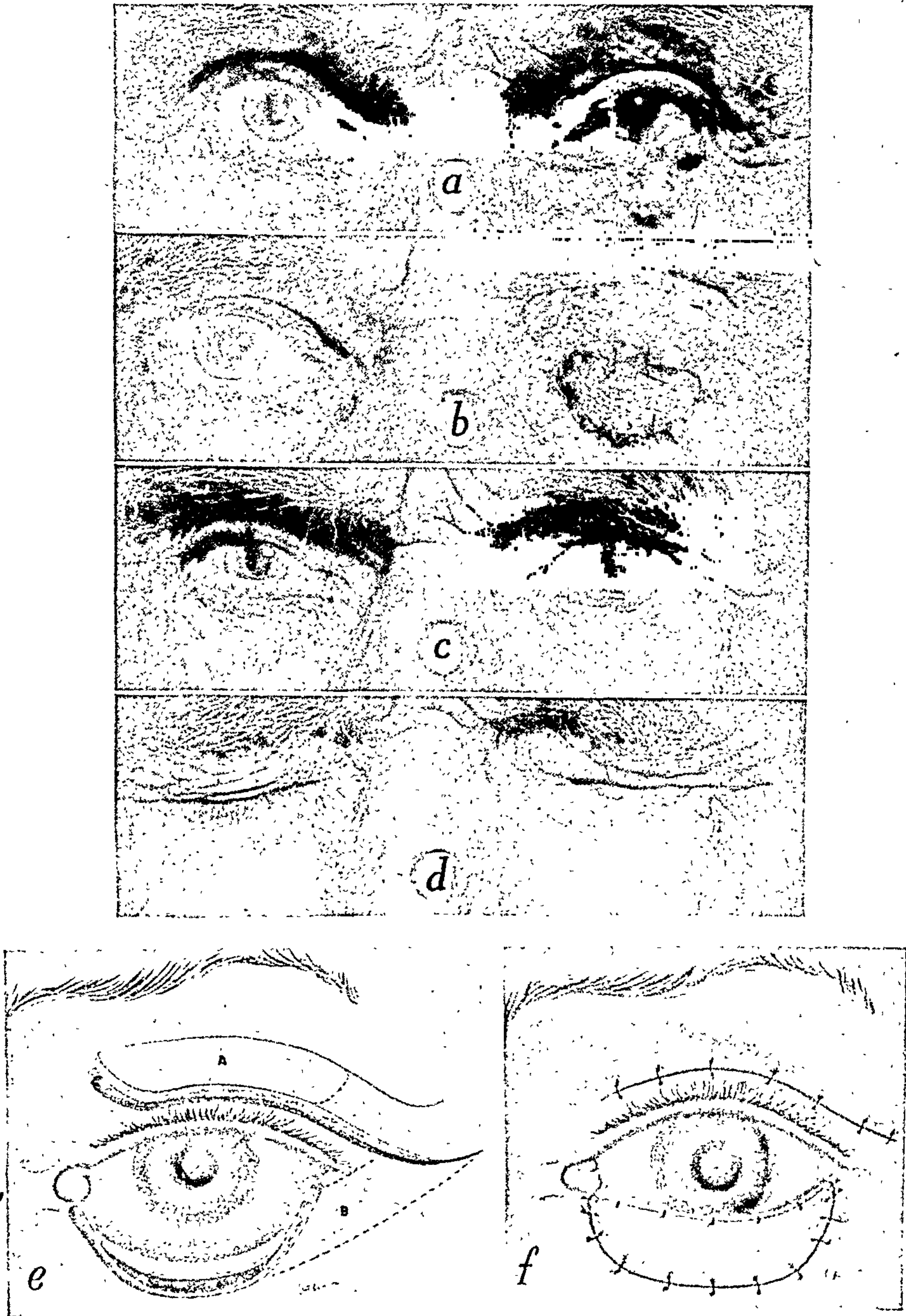


Fig. 142.—Total loss of lower lid. Reconstruction with a tunneled flap. a Carcinoma of lower lid; *b*, full-thickness flap removed from upper lid and tun neled beneath the skin bordering the defect which remained after advancemen of the infra-orbital soft parts; *c*, six months later; condition of lid, eyes open *d*, condition of lid, eyes closed; *e*, A, full-thickness flap excised from upper por tion of upper lid; B, area of skin tunneled between base of flap and margin o defect; *f*, completed repair, sutures in place.

Tunneling of this flap beneath the skin bordering the defect is essential but it does prevent visible facial scar. The skin and : cutaneous tissue may be opened from the midpoint of the lat border of the defect to the base of the flap, the borders of this inci: dissected and the pedicle sutured in its bed.

Dress with a cotton eye pad, fluff gauze, and a firm bandage continue to employ them for forty-eight hours. Remove the stitc and support the stitch line with gauze strips applied with collod

Stage 2.—An interval of two weeks is allowed to elapse betw Stages 1 and 2.

Amputate the pedicle at the lateral border of the defect. Ad the bordering edges of the flap and the defect. Close the muscular skin layers with interrupted sutures of horsehair. Withdraw pedicle from the tunnel, adjust its base, and close with interrup horsehair stitches. Permit the surgical adhesions between the lid: remain.

Stage 3.—After an interval sufficient for healing and organiza of the upper lid, the adhesions are cut with scissors, and the ma of the lid is permitted to heal.

Fig. 142 depicts part of the procedure and the end-result i repair such as has been described. Note in Fig. 142, c, that the leve the lower lid has been depressed as a result of organization and : contraction. The result is good functionally but not cosmetically.

METHOD II

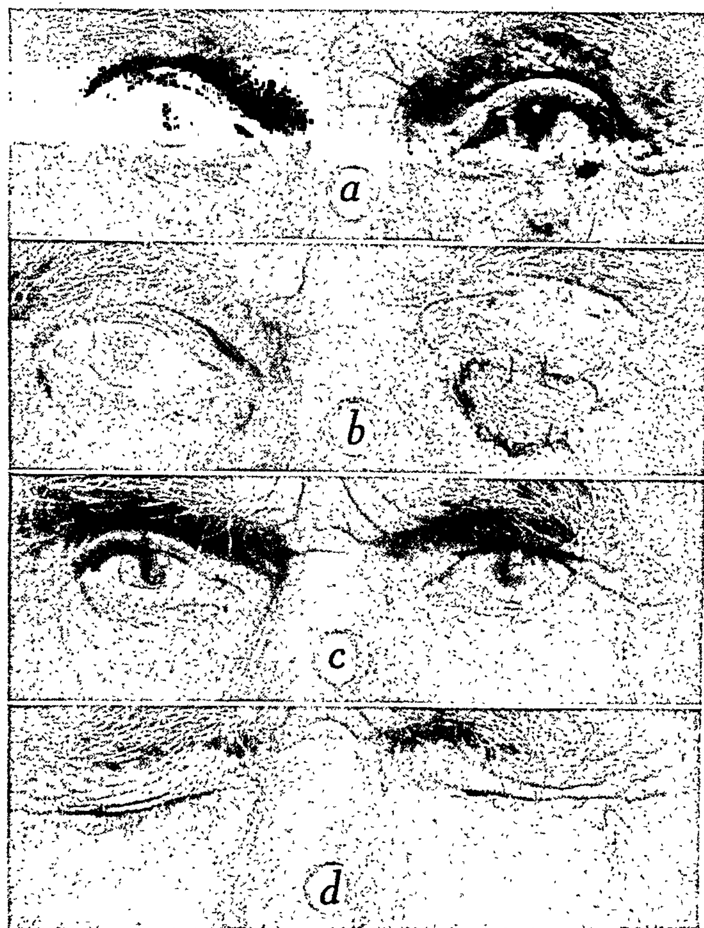
In the procedure considered here the lid is replaced by a hin flap from its border. It is not a procedure of choice but, occasiona one of necessity resulting from injury and loss of the upper lid bordering tissues. It is preferable to employment of a pedicled from the region of the forehead, but is no more desirable than a t neled flap from the forehead, supplied by the anterior temp artery (Fig. 145).

Requirements

Covering skin, conjunctival lining, supporting tissue.

Procedure

Stage 1.—Make a pattern of a hinged flap, with its base line in Fig. 143, along the borders of the conjunctival stump. Dimensi of the flap should be such that when the flap is turned upw ("hinged") there will be a straight lid margin between the two car (Fig. 143, A in *f*). This is an overcorrection and is a necessary all



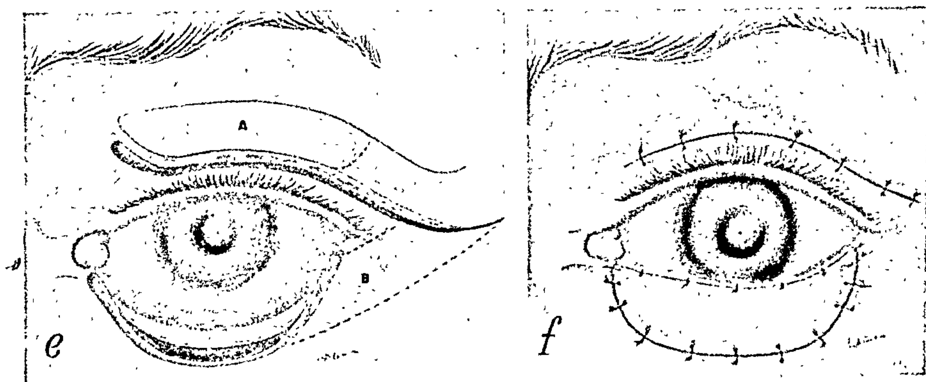


Fig. 142.—Total loss of lower lid. Reconstruction with a tunneled flap. *a*, Carcinoma of lower lid; *b*, full-thickness flap removed from upper lid and tunneled beneath the skin bordering the defect which remained after advancement of the infra-orbital soft parts; *c*, six months later; condition of lid, eyes open; *d*, condition of lid, eyes closed; *e*, A, full-thickness flap excised from upper portion of upper lid; B, area of skin tunneled between base of flap and margin of defect; *f*, completed repair, sutures in place.

ance for subsequent contraction. Apply the pattern and incise the skin along its mesial and lateral border. Scratch the line of its inferior border. Undermine flap A through lateral incisions and shave off its epithelial surface in the manner of cutting a thick, intermediate graft (Fig. 143, A in *e*). Cover this raw surface with a flap of buccal mucous membrane of exact size. Fix the borders of this flap with a few interrupted horsehair sutures.

Apply a thin layer of gauze permeated with scarlet red ointment. Instil boric acid ointment in the eye, cover with a cotton eye pad and fluff gauze, and apply a firm bandage. This dressing should remain in place twelve days, unless there is local pain or abnormal drainage.

Stage 2.—An interval of fifteen days is allowed to elapse between Stages 1 and 2.

Incise the borders of the flap and dissect and fold it upward. Close the approximating edges of the flap with several interrupted sutures of fine silk (Fig. 143, *f*, A). Obtain a full-thickness skin flap, having the exact size of the defect, from the back of the ear and approximate it to the skin borders of the defect with interrupted sutures of horsehair. Approximate the mucous membrane of the lining flap to the upper edge of the grafted flap with interrupted sutures of fine silk. Dress as in Stage 1 for a period of twelve days. Continue a lighter dressing, consisting of a cotton eye pad and fluff gauze for several days following this period.

Close the defect on the back of the ear by undermining and sliding its borders. If this is not possible, the defect is repaired with a thick, split skin graft taken from some other surface of the body.

The graft on the lid may be a thick intermediate cut taken from some other surface of the body, rather than a full-thickness flap from the back of the ear, but the texture and color of the flap from the ear are usually more satisfactory than those of other skin.

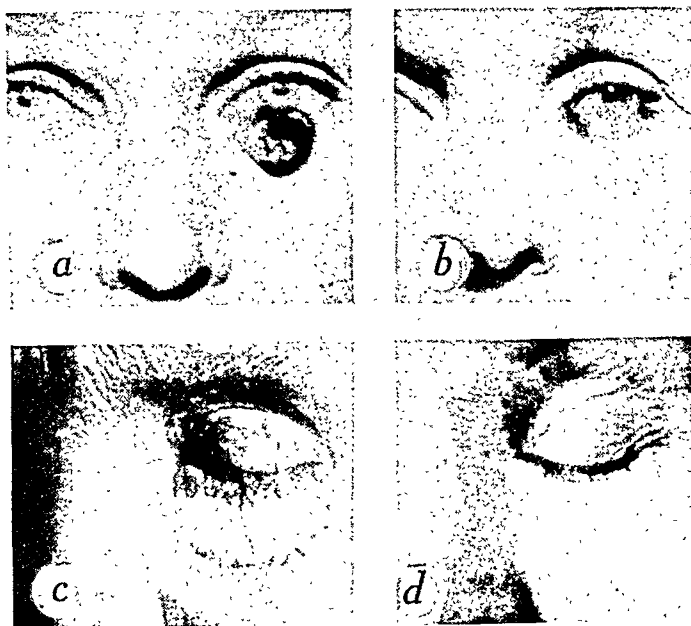
The result of such a procedure is pictured in Fig. 143.

METHOD III

In the method described here, replacement is by a prepared pedicle, forehead flap. This *procedure is not a method of choice*, but occasionally, one of necessity. Such flaps for the repair of lids, face, and nose should be avoided when less mutilating procedures can be employed (Fig. 144).

Requirements

Covering skin, supporting tissue, conjunctival lining.



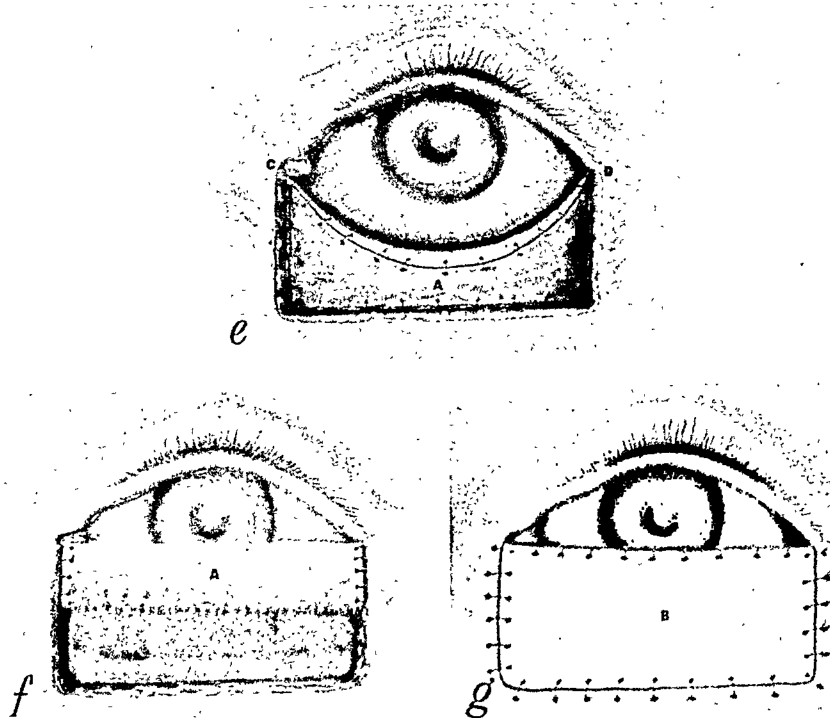


Fig. 143.—*a*, Sarcoma of lower lid; *b*, appearance of patient after excision and advancement of bordering infra-orbital skin; *c*, appearance of the graft on first removal of dressing (twelve days); *d*, appearance of reconstructed lid (eye closed) several months later; *e*, A, mucous-membrane graft on an outlined skin flap; CD, margin of conjunctival remnant; *f*, A, grafted flap folded to replace lining and cul-de-sac; the margins of the flap are approximated with fine silk sutures; *g*, B, full-thickness skin graft from mesial surface of ear.

defect. Approximate all skin borders with interrupted sutures of horsehair. Apply a cotton eye pad, fluff gauze, and a firm bandage.

Undermine the scalp bordering the defect left by elevation of the pedicle. Approximate these borders as far as possible by sliding, and with a few small, tension sutures of silkworm gut. Cover the defect with several thicknesses of gauze permeated with scarlet red ointment, fluff gauze, and a bandage. Remove the skin sutures from the lid at the end of two days and support with strips of gauze applied with collodion.

Stage 3.—The interval between Stages 2 and 3 is three weeks.

Amputate the pedicle, dissect it from its bed, and return it to the scalp. Undermine the skin borders of the facial defect and approximate all skin edges with interrupted sutures of horsehair. Remove sutures on the second day, support with strips of gauze and collodion.

METHOD IV

In the method now to be considered, replacement is with a prepared forehead flap as a tunneled pedicle, supplied by the temporal vessels. This procedure is preferable to the preceding one, in which a pedicled flap from the scalp is employed. It eliminates entirely one procedure and produces much less cosmetic disability.

Requirements

Skin covering, conjunctival lining, supporting tissue.

Procedure

Stage 1.—Make an accurate pattern of the defect. Outline this pattern on the forehead, at the distal end of the anterior branch of the temporal artery (Fig. 145, A). The location of this flap is determined by the length of the pedicle which will permit its transference to the defect. Incise the superior, inferior, and mesial borders of this flap. Undermine. Graft the raw surface and superior edge of the flap with buccal mucous membrane of the exact required pattern. Approximate the edges of the flap with a few interrupted sutures of horsehair. Apply a firm fluff gauze dressing and continue it in use for a period of twelve days.

Stage 2.—Outline the course of the anterior branch of the temporal artery leading to the lateral margin of the forehead flap (Fig. 145, *top*, B). Carry an incision through the scalp, but *not into the underlying subcutaneous tissue*, from the end of the flap to a point bordering the helix of the ear (Fig. 145, *top*, B). Separate the scalp bordering this incision. Incise along the borders of the temporal

Procedure

Stage 1.—Outline a narrow flap of scalp, including the anterior temporal artery and its branches, in the hair-bearing area, so that its distal end is placed on a hairless portion of the forehead. Incise the lateral and distal borders of the hairless portion of this flap, in a pattern which will replace the defect in the lid. Elevate this flap. Graft its raw superior border and base surface with buccal mucous membrane of a size and shape to replace the conjunctival defect. Replace the flap in its bed, approximate its borders with a few in-



Fig. 144.—Total loss of lower lid and bordering infra-orbital tissues. Interpolated scalp and forehead flap containing the temporal artery.

terrupted horsehair sutures, and apply a firm gauze dressing. Continue use of the dressing for twelve days.

Stage 2.—An interval of fifteen days passes between Stages 1 and 2.

Incise the borders of the pedicle and flap. Free the flap. Make an incision from the base of the anterior edge of the flap, through the skin and subcutaneous tissue of the face, to the borders of the defect. Dissect the borders of this incision and rotate the pedicle of the flap into this base. With interrupted sutures of fine silk, suture the borders of the mucous membrane on the flap to the borders of the conjunctival

vessels to the periosteum in a manner that will include these vessels in a pedicle of tissue about ¼ inch (0.6 cm.) in width (Fig. 145, *middle*, D). Incise and free the flap and the vascular pedicle, already outlined, down to the helix of the ear (Fig. 145, *middle*, C, A). Undermine the skin and subcutaneous tissue from this incision in front of the ear to the lateral margin of the defect in the lid.

Pull the prepared flap and its vascular pedicle through the tunnel beneath the skin and approximate it to the defect. Take care that the vascular pedicle is not kinked at the point of turning into this tunnel. If this occurs, the skin should be opened along the artery in front of the ear to provide a greater arc for its rotation. Approximate the mucous membrane of the flap to the conjunctival borders of the defect with interrupted sutures of fine silk. Approximate the skin with interrupted sutures of horsehair. Close the scalp defect with interrupted horsehair sutures.

Instil boric acid ointment into the eye; apply a cotton eye pad, fluff gauze, and moderately firm dressing. Continue use of the dressing for forty-eight hours. Remove the skin stitches and support with gauze strips applied with collodion. Remove the silk stitches from the conjunctiva on the eighth day or shortly thereafter.

METHOD V

According to this method, the lost tissues are replaced with normal structures from the opposing lid (Dupuy Dutemps). This is the *procedure of choice.*

Requirements

Skin, musculotarsal layer, conjunctival lining.

Procedure

Stage 1.—Make an incision in the conjunctiva, 1 mm. from the margin of the lid, extending from one canthus to the other. This incision should be designed to avoid injury to the hair follicles of the eyelashes (Fig. 146, *6*, A). Free the skin from the underlying musculotarsal layer with small, curved, blunt-nosed scissors (Fig. 146, *6*, B).

If infra-orbital soft tissue has been lost, the defect is obliterated by undercutting the borders of the defect, elevating this tissue, and fixing it to the infra-orbital margin with several interrupted sutures of catgut (Fig. 146, D).

Suture the conjunctival stump, C, to the free edge of the flap, B, of the upper lid, using interrupted stitches of fine silk (Fig. 146, *7*,

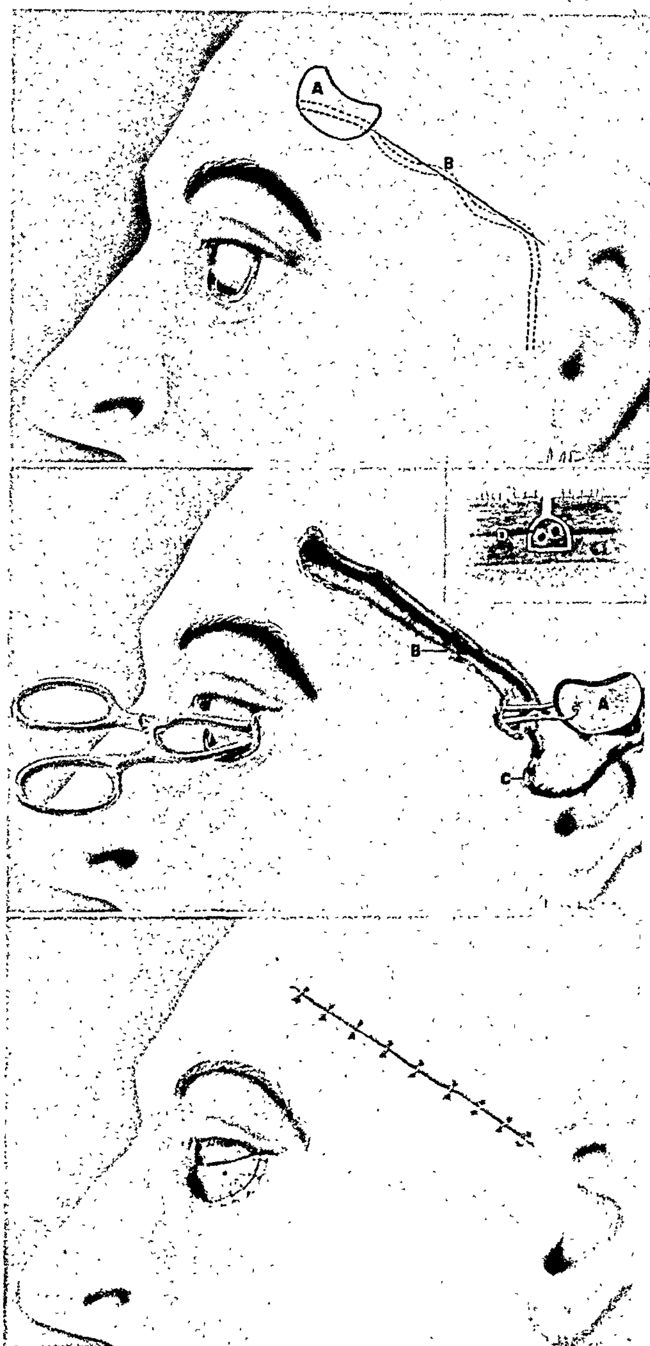


Fig. 145.—Total loss of lower lid. Use of forehead flap and tunneled pedicle containing temporal artery. *Top,* outline of flap, A, on distal end of the artery; the raw surface of this flap is grafted with mucous membrane; *middle,* incision, B, in scalp; C, anterior temporal artery and vein enclosed in subcutaneous tissue; D (inset), cross-section of pedicle, C; A, grafted scalp flap; the forceps are inserted beneath the tunneled skin to grasp the flap, A, and draw it into the defect; *bottom,* completed repair.

BC). Tie these sutures *tightly* and leave their ends long enough to project on the face (Fig. 146, *2, 7*). Approximate the edge of the line of incision on the posterior surface of the lid, A, and the raw edge of the skin bordering the defect, using interrupted horsehair sutures (Fig. 146, *2*).

Apply a cotton eye pad, fluff gauze, and a moderately firm bandage. Remove the skin stitches on the second day and apply two or three strips of gauze with collodion across the line of suture. The silk stitches in the conjunctiva will cut out by the fifth or sixth day, and this will permit removal by traction.

Stage 2.—An interval of three to four weeks is allowed to elapse between Stages 1 and 2. This is the minimal time required for establishment of adequate blood supply across the line of approximation of the conjunctiva. A longer interval is desirable when circumstances will permit.

Incise the scar along the line of union of the upper lid and the cutaneous margin of the defect. Dissect the skin from the underlying soft tissues with small, blunt, curved scissors. Elevate the lid and lash margin to its normal level (Fig. 146, *8*). Outline, incise, and elevate a pedicled flap from the skin of the upper lid, of a length and width sufficient to fill the skin defect in the lower lid. Rotate this flap and stitch it to the borders of the defect with interrupted sutures of fine horsehair (Fig. 146, 3). Close the defect in the skin of the upper lid with interrupted sutures of fine horsehair (Fig. 146, *3*). Approximate the upper lid and the upper margin of the transposed flap with interrupted sutures of fine horsehair (Fig. 146, *3*). Apply a cotton eye pad, fluff gauze, and moderately firm dressing. Remove all skin stitches on the second day and support with cotton gauze applied with collodion.

Stage 3.—The interval between Stages 2 and 3 is three weeks.

Insert one blade of blunt-nosed scissors beneath the conjunctiva at the outer canthus. Incise the full thickness of the lid, along the margin of the upper lid, to the caruncle at the inner canthus (Fig. 146, *9*). Control the oozing on the margin of the lid with sponge pressure. Instil boric acid ointment into the eye. Cover with a cotton eye pad, fluff gauze, and bandage with a moderate pressure. Continue use of such dressings for twenty-four hours. Permit the raw margin of the lower lid to epithelize. The results of such a procedure are depicted in Fig. 146.

Lashes can be grafted on the lower lid if this seems desirable.

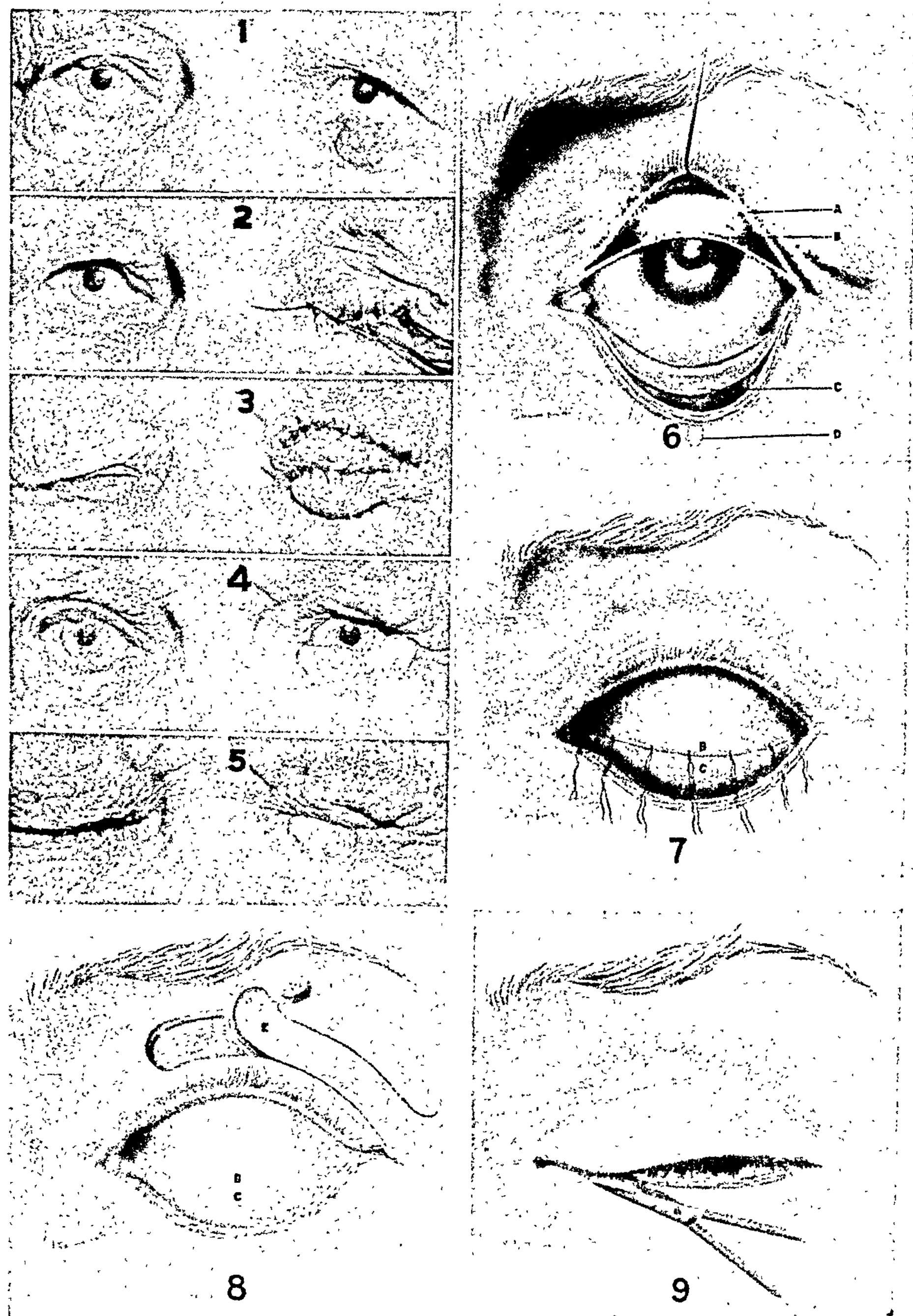


Fig. 146.—Total loss of lower lid. Dupuy Dutemps procedure. *1*, Carcinoma of lower lid; *6*, the defect resulting from excision of lower lid and bordering soft parts is partially obliterated by advancement of the surrounding infra-orbital skin, which is fixed with catgut sutures to the orbital margin, D; A, separated skin of upper lid; B, "musculotarsoconjunctival" layer; C, conjunctival stump; *2*, suture of skin margin of upper lid to skin margin of lower defect; *7*, approximation of B and C with fine, tightly tied horsehair sutures; *3* and *8*, skin flap, E, from upper lid to replace skin defect in lower lid; *9*, separation of the two lids with scissors along line between the two canthi; *4*, condition of lid, eye open, after reconstruction; *5*, condition of the lid, eye closed, after reconstruction.

and length to provide a double layer (p. 23). Prepare the graft as directed on page 23. Pass a dermal suture, which is armed with a straight cutting needle on each end, through each of the distal corners of the graft. Pass these needles through the incision and beneath the tunneled skin to emerge at the lateral border of the defect (Fig. 15). Draw the graft into the tunnel and remove the traction sutures. Close the skin incision with interrupted horsehair sutures.

Apply a firm, fluff gauze dressing and continue it in use for several days. This dressing should remain until danger of collection of fluid has passed and adhesion between the graft and soft parts has occurred. The defect should be overcorrected. An allowance of 10 per cent to 20 per cent for shrinkage during organization of the graft should be made. The procedure can be repeated after proper intervals, as often as necessary to obtain the desired result.

DISPLACEMENT OF EYEBROW

Correction of this condition can be effected by transposition of flaps. This simple procedure, with its result, is depicted in Fig. 148.

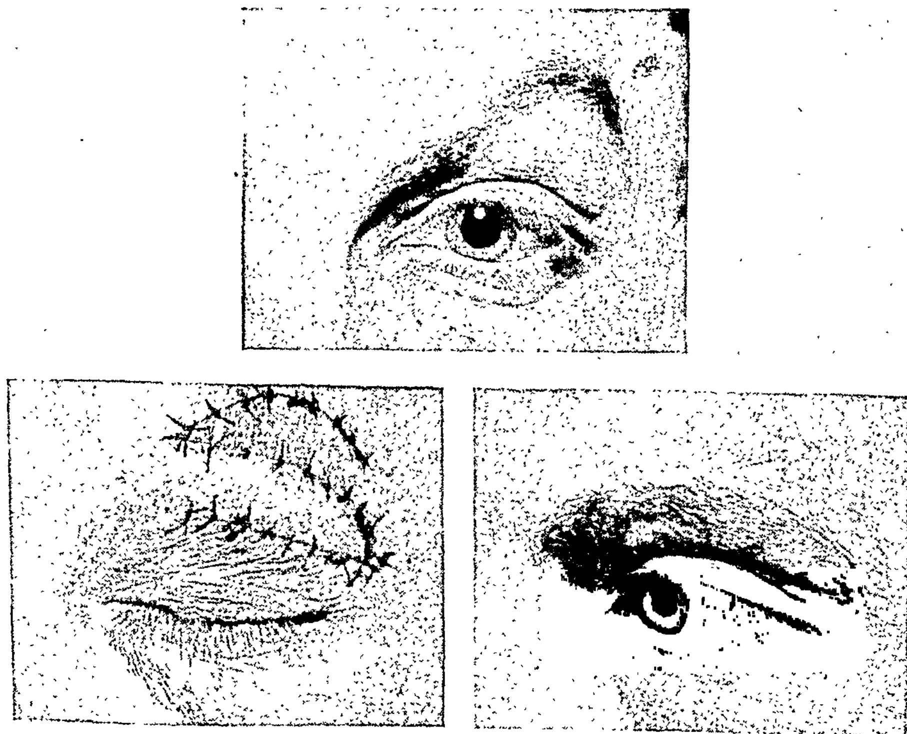


Fig. 148.—Displaced eyebrow. Correction by transposition of flaps.

A flap, with its base on the mesial normal portion of the brow, is transposed with a flap which has its base in the temporal region and is taken from the hairless skin beneath the elevated brow.

SUNKEN EYEBALL: TROPHIC ABSORPTION OF ORBITAL SOFT PARTS

This very disabling and unsightly deformity frequently follows trauma to and about the orbit. Its results are depicted in Fig. 147. Repair with a subcutaneous graft (dermal) is considered here.

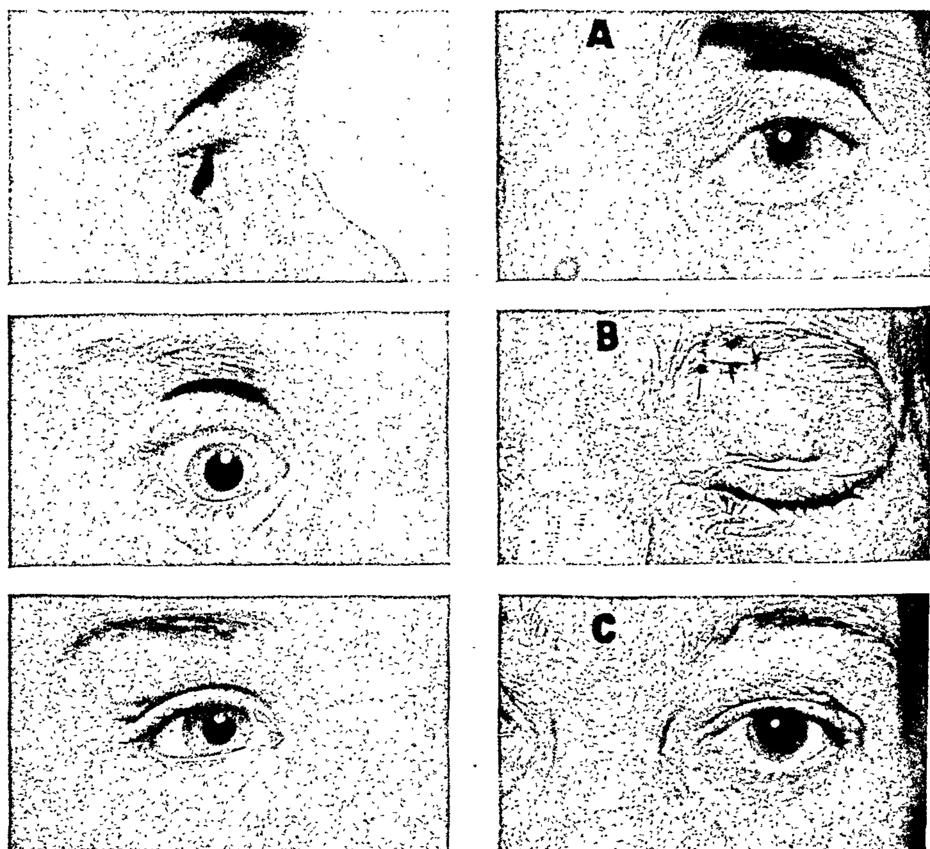


Fig. 147.—Trophic absorption. *Left column,* appearance of sunken lids before (*top* and *middle*) and after (*bottom*) correction; *right column,* A, sunken upper eyelid before correction; B, point of insertion of dermal graft; simple suture; C, appearance of lid ninety days after insertion of graft.

Requirements

Supporting tissue beneath the skin and subcutaneous tissues of the lids.

Procedure

Make an incision ¼ or ⅜ inch (about 0.6 or 1 cm.) in length through the skin at the lower margin of the eyebrow (Fig. 147, B). Separate the skin and subcutaneous tissue of the lid with small, curved, blunt-nosed scissors. Carry this dissection well beneath the bony margin of the orbit. Dissect a strip of skin of sufficient width

and length to provide a double layer (p. 23). Prepare the graft as directed on page 23. Pass a dermal suture, which is armed with a straight cutting needle on each end, through each of the distal corners of the graft. Pass these needles through the incision and beneath the tunneled skin to emerge at the lateral border of the defect (Fig. 15). Draw the graft into the tunnel and remove the traction sutures. Close the skin incision with interrupted horsehair sutures.

Apply a firm, fluff gauze dressing and continue it in use for several days. This dressing should remain until danger of collection of fluid has passed and adhesion between the graft and soft parts has occurred. The defect should be overcorrected. An allowance of 10 per cent to 20 per cent for shrinkage during organization of the graft should be made. The procedure can be repeated after proper intervals, as often as necessary to obtain the desired result.

DISPLACEMENT OF EYEBROW

Correction of this condition can be effected by transposition of flaps. This simple procedure, with its result, is depicted in Fig. 148.



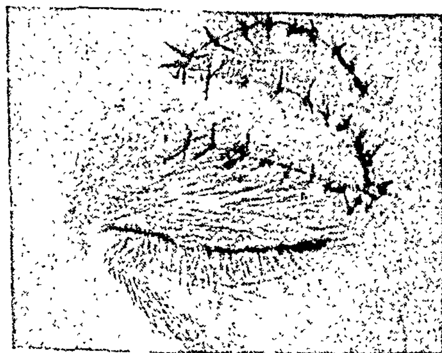




Fig. 148.—Displaced eyebrow. Correction by transposition of flaps.

A flap, with its base on the mesial normal portion of the brow, is transposed with a flap which has its base in the temporal region and is taken from the hairless skin beneath the elevated brow.

REPLACEMENT OF EYEBROW

The absence of an eyebrow is a striking cosmetic disability. The brow can be restored by one of several procedures: (1) The opposite

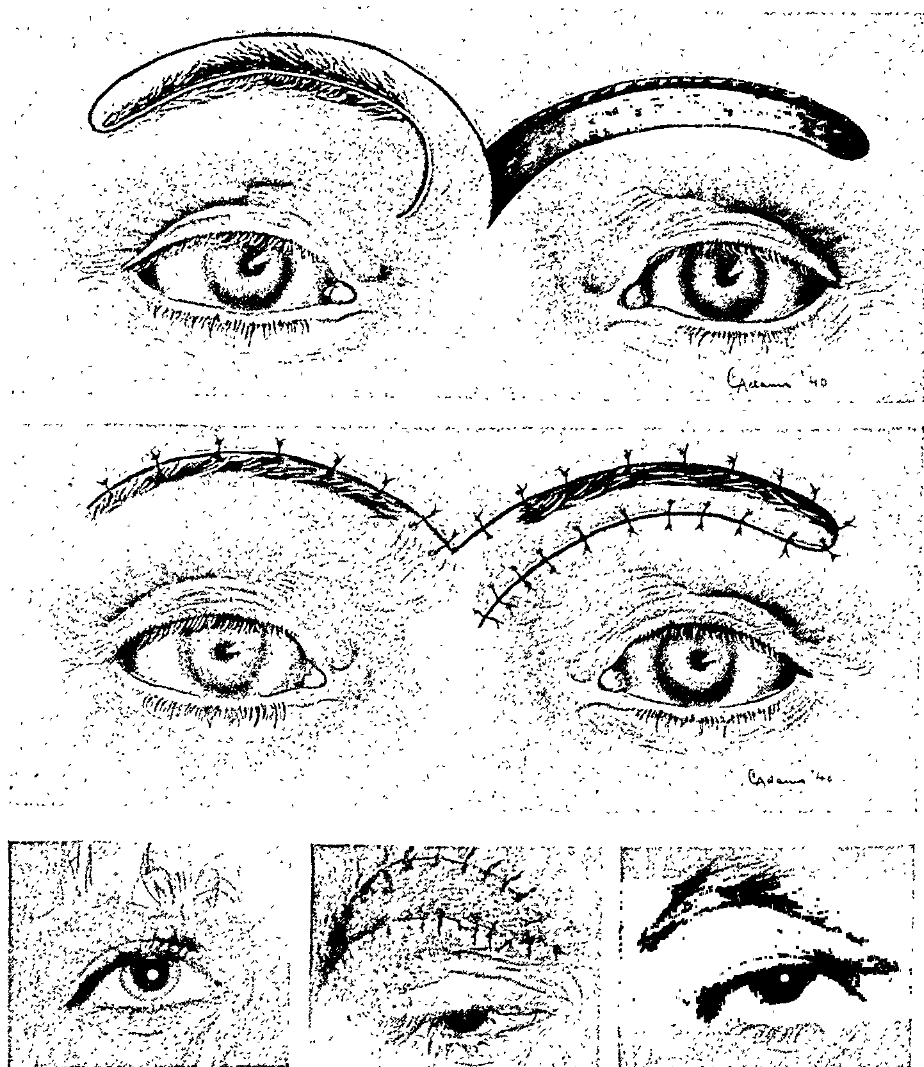


Fig. 149.—Replacement of eyebrow. *Upper bilateral view,* pedicled flap containing frontalis artery in its base and including half of existent eyebrow; preparation of bed for transposed flap; *lower bilateral view,* transposed flap; approximation with simple suture.

Bottom row, left, absence of eyebrow; *middle,* replacement with scalp graft from behind ear; appearance of graft on twelfth day; *right,* new eyebrow.

brow can be divided lengthwise and half of it transferred to replace the absent one. (2) Hair from the temporal region can be taken from behind the ear or the midline of the occipital region. The chosen flap must furnish hair growing in the *proper direction* for the new brow.

(3) A hair-bearing flap utilizing the anterior temporal vessels as a tunneled pedicle may be taken from the temporal region of the scalp. This flap with its vascular pedicle is brought into its new location through a tunnel beneath the scalp (Fig. 145).

Pedicled Flap from Opposite Eyebrow

Make a curved incision, beginning on the lateral aspect, of the glabellar region and extending to the lateral end of the good brow, through its midline (Fig. 149, *upper bilateral view*). Make a second incision, parallel to the first and 7 or 8 mm. above it, from the midline to join the first incision at the tip of the brow. These two incisions should include the frontalis artery. Make an incision in the bald side, along the line of the normal brow. Dissect the scalp on each side of it to provide a bed. Elevate and rotate the divided brow. Approximate all edges with interrupted horsehair sutures. Apply a gauze dressing. Remove the sutures on the second day. Support with gauze strips applied with collodion.

Free Grafts

These can be obtained from the hair-bearing scalp behind the ear on the same side (Fig. 149, *bottom row*) or from the midline of the scalp in the occipital region.

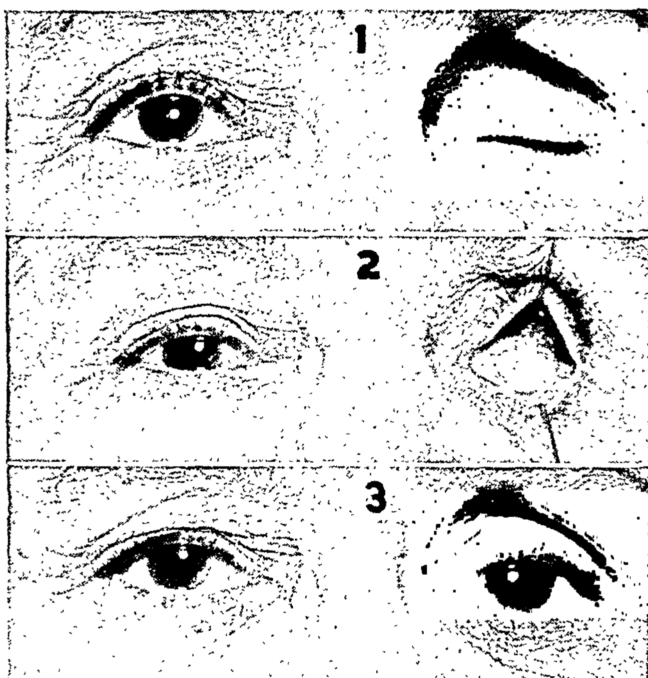
Cut the grafts *larger* than the desired brow to allow for loss of hair follicles on its margins. Plant in a dissected bed in the desired area. Dress with proper pressure and continue to employ the dressings for twelve days (p. 60). Finally, after the hair is growing, trim the graft to the desired size and approximate the bordering scalp.

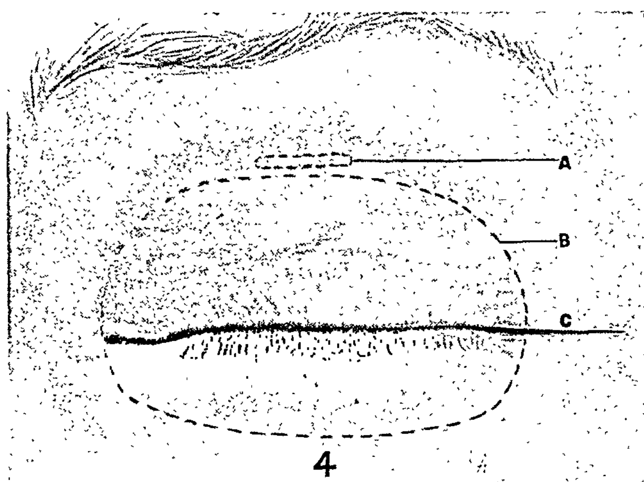
EPITHELIAL LINING OF ORBITAL CUL-DE-SAC

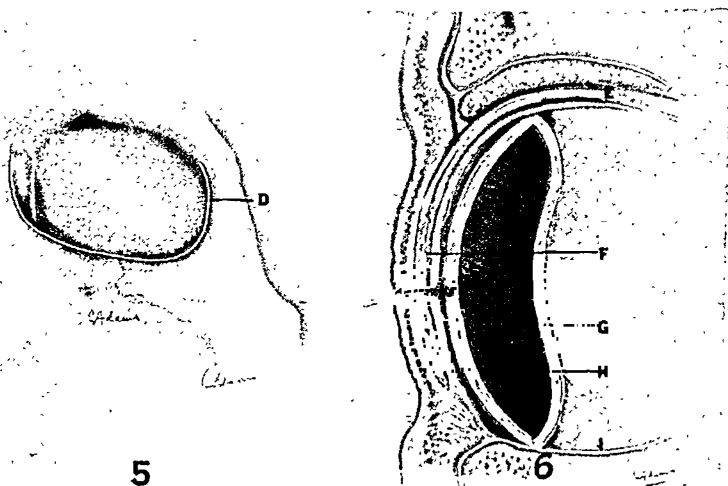
The purpose is to produce a lined sac or pocket for a prosthetic eye, which will retain the prosthetic eye in a stable manner without weight or pressure on the lower lid (Fig. 150).

Procedure

External canthotomy is performed. The sac formed is larger than the normal palpebral slit. Introduction of the skin-covered mold requires this opening (Fig. 150, *4*, C). The dissection begins slightly above and below the margins of the respective lids and is carried along the plane of the normal conjunctiva. The tarsus serves as a guide in places where the conjunctiva has been destroyed. The *tarsus and the attachment of the levator muscle must be preserved.* The dissection of the upper lid is carried superiorly and posteriorly but


1
2
3


A
B
C
4


D
F
G
H
5
6

does *not extend* to the periosteum of the roof; space is left for the levator muscle (Fig. 150, *4,* A). It is carried to the periosteum on the temporal side, inferiorly along the floor and mesially behind the caruncle and along the anterior crest of the lacrimal fossa (Fig. 150, *5,* D). Remove granulations and scar tissue and obliterate any tracts or pockets.

Mold sterile (autoclave) dental modeling compound into the formed pocket. This is so shaped as not to distort the lids (Fig. 150, *6,* H). Cover the mold with split skin which *contains no corium.* Arrange the skin, raw surface external, so that its approximating edges correspond to the margins of the lids (Fig. 150, *6,* G). Insert the skin-covered mold. Approximate the margins of the lids and retain them in approximation with several strips of fine-meshed gauze applied with collodion vertically across the lids.

Apply strips of oiled silk or rubber treated with boric acid ointment to each lid, so that the margins of the lids remain uncovered. Apply also a cotton eye pad, gauze, and strips of adhesive tape for retention. Finally, a bandage is applied with moderately firm pressure. Remove the dressing in six or seven days. Clean and dry the lids *gently. Do not attempt to inspect the graft.* Apply dressings as above, but with less pressure. Dress daily thereafter, or as required.

Remove the mold in ten or twelve days from the time it was inserted. Dry in air or with an electric-light bulb. Replace the mold. This process is repeated daily until organization has occurred. It is well to oil the graft after two or three days of this daily routine with such oil as is used in the nursery. Repair the wound of canthotomy. Oil. Place a light dressing of gauze ribbon in the socket. Insert the prosthesis as soon as the line of suture of the canthotomy is well healed (p. 373).

ORBITAL RECONSTRUCTION FOR PROLAPSED EYEBALL

In the case under consideration here, the prolapse was attributable to loss of the bony floor and displacement of the malar (zygomatic) bone.

The patient pictured in Fig. 151, *upper,* suffered a compound, comminuted fracture of the malar, infra-orbital, and nasal regions. The

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Fig. 150.—Epithelial lining of the orbital cul-de-sac. *1,* Original condition; *2,* completion of cul-de-sac; *3,* prosthetic eye in cul-de-sac; *4,* A, location of levator muscle; B, limit of dissection of soft parts; C, canthoplasty; *5,* D, line of desired adhesion between periosteum and implanted cutaneous lining of sac; *6,* E, levator muscle; F, tarsus; G, skin graft; H, mold supporting skin graft and producing the desired form of the constructed cul-de-sac; I, contact between skin graft and periosteum of orbital floor.

malar fragment was driven downward, backward, and inward into the posterior portion of the maxillary antrum. The mesial portion of its orbital attachment was fractured from the body of the bone and was removed. Almost all of the bony floor of the orbit and all of the thin bone of the wall of the canine fossa were removed by the attending surgeon. The malar bone remained because of its position in the antrum behind the prolapsed soft orbital content and the eyeball.

The situation represented in Fig. 151, *upper,* graphically demonstrates the *fallacy of removing loose fragments of bone which retain any attachments whatsoever.*

Requirement in Circumstances Such As Have Been Described

Reconstruction of the orbital floor to furnish support for the orbital content. This requirement has been met by suturing a broad strip of fascia lata to the periorbita attached to the mesial and lateral borders of the frontal bone. This forms a tough, inelastic sling or hammock. The use of cartilage introduced immediately above the inferior portion of the prolapsed periorbita fails to produce a desirable result. The *procedure of choice* is reduction of the fractured and displaced bony elements and restoration of the bony floor. The procedure is rarely necessary if the first aid and subsequent immediate care are conservative and intelligent.

Procedure

Make an incision 1½ inches (3.8 cm.) long about ⅜ inch (about 1 cm.) above the gingival border in the canine fossa. Separate the soft parts to permit entrance into the antrum. Gently separate and elevate the orbital content and reduce all fractured elements of the antral walls.

In this instance the malar bone was freed of its organized attachments and was reduced to approximate its zygomatic and frontal articulations (three months after fracture). That portion of the malar bone forming the middle of the lower orbital margin was missing. Packing of iodoform ribbon gauze was placed in the antrum to maintain the globe and orbital soft parts in extreme elevation for forty-eight hours. This packing was removed through the canine incision, and a lighter packing was maintained for eight days. This resulted in sufficient adhesion of the orbital soft parts to permit withdrawal of the packing.

The V-shaped cutaneous scar below the lower lid was opened and dissected to the remaining periorbita and scar beneath the globe. This dissection was carried mesially and laterally to the frontal processes

on each side. The periorbita in these frontal areas was incised and separated, and the underlying surfaces of bone were freshened with a chisel.



Fig. 151.—*Upper,* prolapsed eyeball and orbital content; loss of bony floor of orbit; appearance six weeks after injury; *lower,* condition after reconstruction of orbital floor with an osteoperiosteal bone graft.

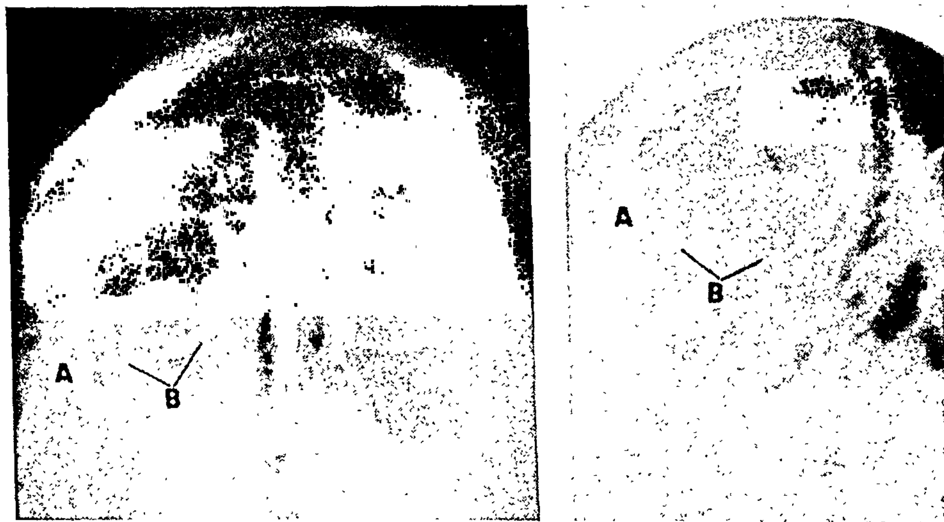


Fig. 152.—Same case as that represented in Fig. 151. *Left,* roentgenographic study several days following the initial repair; the zygomatic (malar) bone, A, and the osteoperiosteal graft, B, have been displaced downward and inward after reduction by the pull of scarring on the fragment; *right,* two months after taking of roentgenogram at the left; position of zygomatic bone, A, and osteoperiosteal graft, B, after secondary reduction and union.

An osteoperiosteal graft (pp. 20, 304) of proper length and desired width was removed from the flat surface of the left tibia. This was introduced into the dissected pocket beneath the eye, with its perio-

steal surface upward. The ends of the graft were slid under the incised periosteum in the two frontal regions so that the bony surfaces of the graft and the freshened areas approximated. Packing was again introduced into the antrum to support the graft and maintain the globe in extreme overcorrection. The packing was removed after several days. It was subsequently noted that the eyeball had gradually become displaced downward. Roentgenologic study of the region revealed that the pull of scarring had displaced the malar bone and the graft (Fig. 152, *left,* A, B). The malar bone was further freed of scar attachments and was reduced to its normal position. The bone graft was again supported by antral packing for several days. The final position of the malar bone and the graft is evident in Fig. 152, *right,* A, B.

CHAPTER VII

OTOPLASTY

SMALL defects of the helix are repaired by utilizing the tissues of the posterior border of the defect. Flaps of skin are transposed or rolled into the defect. Small defects in the body are repaired by elevating a flap, or flaps, from the mesial cutaneous surface and turning these through the perforation to be stitched to the margin of skin about the defect on the lateral surface. The denuded surface remaining on the mesial aspect can be grafted at the time or, preferably, a few days later.

A *larger defect* is readily repaired by cutting and delaying a flap from the hairless skin over the mastoid region. The base of this flap is the margin of the defect. The flap is elevated and sutured to the cutaneous margins on the lateral surface of the defect and then folded on itself to be sutured to the cutaneous margins on the mesial surface of the defect. The remaining raw area is repaired with a thick, split skin graft. (For anesthetic procedures, see Section IV.)

SMALL DEFECT OF AURICLE

This can be repaired with a hinged flap from the mesial aspect and a transposed flap from the mastoid surface.

METHOD I

Procedure

Incise and dissect two small, rectangular flaps from the upper and lower borders of the defect (Fig. 153, *left*). Approximate the free ends of these flaps with two or three interrupted horsehair sutures passed from the lateral aspect of the ear. Suture the margins of the flaps to the skin margin on the lateral aspect of the ear (Fig. 153, *middle*). Elevate a tongue-shaped flap, with its base downward, from the skin covering the mastoid region and transplant it in the defect created by elevating the auricle flaps (Fig. 153, *middle* and *right*). Approximate with interrupted horsehair sutures (Fig. 153, *right*). Apply a smooth dressing of gauze behind the ear; apply gauze dressing and moderately firm bandage. Remove all skin stitches on the second day. Support with strips of gauze and collodion.

METHOD II

By this method, skin from the mastoid region is utilized for the repair.

Procedure

Stage 1.—Elevate a tongue-shaped flap of skin of proper dimensions from the skin of the mastoid region (Fig. 154, *a*). Rotate the end of the flap 90 degrees and suture its distal end and lateral margins to the superior and lateral edges of the external defect in the skin (Fig. 154, *b*). Apply gauze dressing and moderately firm bandage.

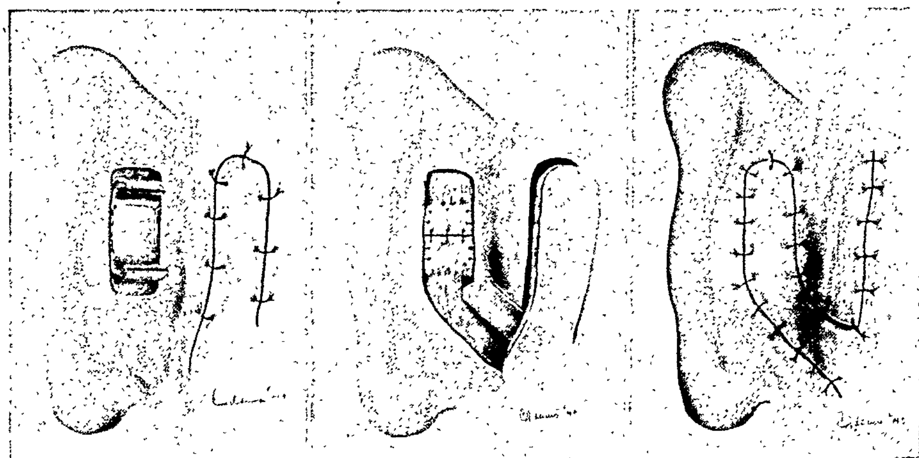


Fig. 153.—Small defect of the auricle. *Left,* lining flaps elevated from the border of the defect; covering flap elevated and delayed; *middle,* hinged flaps of skin from the mesial surface reflected and sutured to form the external covering skin of the defect; *right,* skin flap from the scalp sutured into the mesial defect.

Stage 2.—An interval of fifteen days is allowed to elapse between Stages 1 and 2.

Amputate the base of the flap; fold it on itelf and suture its upper and lateral margins to the borders of the cutaneous defect. Undercut the borders of the scalp defect and approximate with interrupted sutures (Fig. 154, c).

Stage 3.—The interval between Stages 2 and 3 is three weeks.

Adjust the inferior border of the transplanted flap to the inferior margin of the defect, using interrupted horsehair sutures (Fig. 154, *d*).

LARGE PARTIAL DEFECT OF AURICLE AND HELIX

This can be repaired with a delayed external covering flap from the mastoid region and a thick, intermediate graft.

Procedure

Stage 1.—Incise, dissect, and delay a flap from the hairless skin over the mastoid region, with its base at the margin of the defect

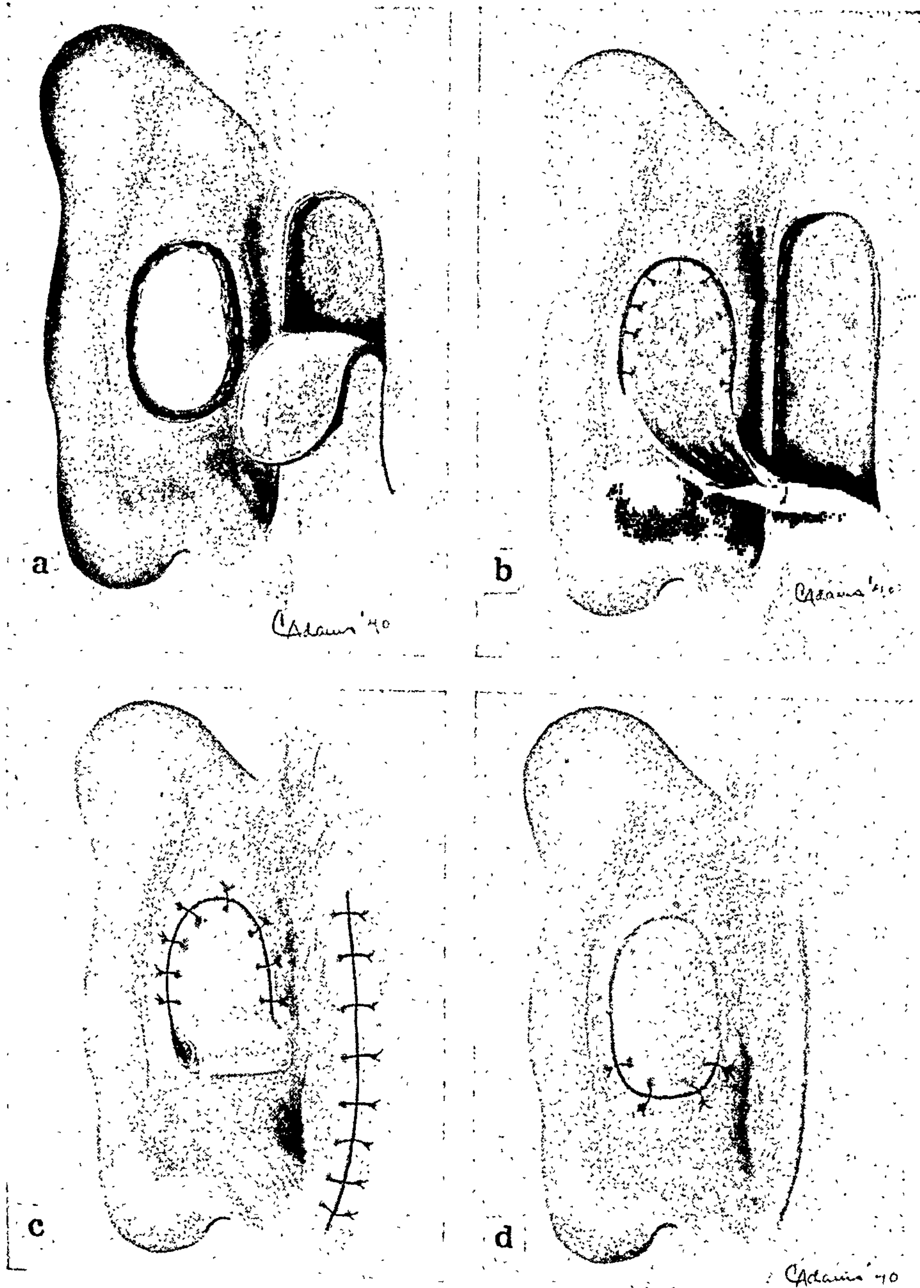


Fig. 154.—Large defect of the auricle. *a*, Flap elevated from the scalp for repair of the defect; *b*, rotated flap sutured to the skin bordering the defect; *c*, pedicled flap amputated; flap folded on itself to cover the mesial cutaneous defect; *d*, skin fold incised; inferior margins of both flaps adjusted and sutured to the bordering skin.

(Fig. 155, *left*). This flap may require elevation and delaying several times before it enjoys an adequate blood supply.

Stage 2.—Elevate the flap and fold it on itself to furnish covering skin for the lateral surface of the ear and a partial covering for the mesial surface. Suture the approximating edges of the flap and cutaneous margins on the lateral surface with interrupted stitches of horsehair (Fig. 155, *middle*). Suture the fold in the flap at a somewhat higher level than the adjacent helix to compensate for ultimate shrinkage and contraction. Suture the remaining portion of the flap to the borders of the defect on the mesial surface of the ear (Fig. 155, *right*).

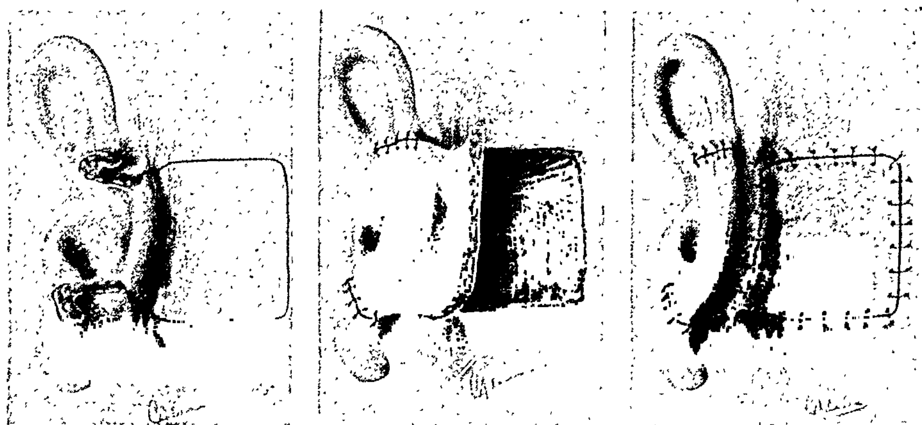


Fig. 155.—Large partial loss of the auricle and helix. *Left,* borders of the defect pared; a scalp flap, based on the border of the defect, is incised; *middle,* flap elevated and reflected forward to approximate the skin margins of the defect externally; *right,* flap folded posteriorly to approximate borders of mesial defect; split skin graft covering scalp defect in mastoid region.

Stage 3.—Repair the remaining defect on the mesial surface of the ear and over the mastoid region with a thick, intermediate skin graft (Fig. 155, *right*). Apply a formed, flattened gauze dressing behind, fluff gauze on the lateral aspect of, the ear, and a firm bandage. Open the dressing on the fifth or sixth day and remove the skin sutures.

RESTORATION OF LOBULE (NÉLATON AND OMBRÉDANNE)

Procedure

Stage 1.—Incise a rectangular flap of proper dimensions, with its base on the neck and the distal end in the skin behind the ear (Fig. 156, *left*). Elevate and delay this flap. Elevate the distal end of the flap, pare the skin on the border of the defect, and suture this to the distal end of the flap (Fig. 156, *middle*).

Stage 2.—An interval of three weeks is allowed to elapse between Stages 1 and 2.

Amputate the base of the flap at a sufficient distance from its attachment to the ear to permit folding, with dimensions sufficient for the lobule. Elevate the flap and suture it to the skin margin of the defect on the mesial surface. Approximate the borders of this folded flap with interrupted horsehair sutures.

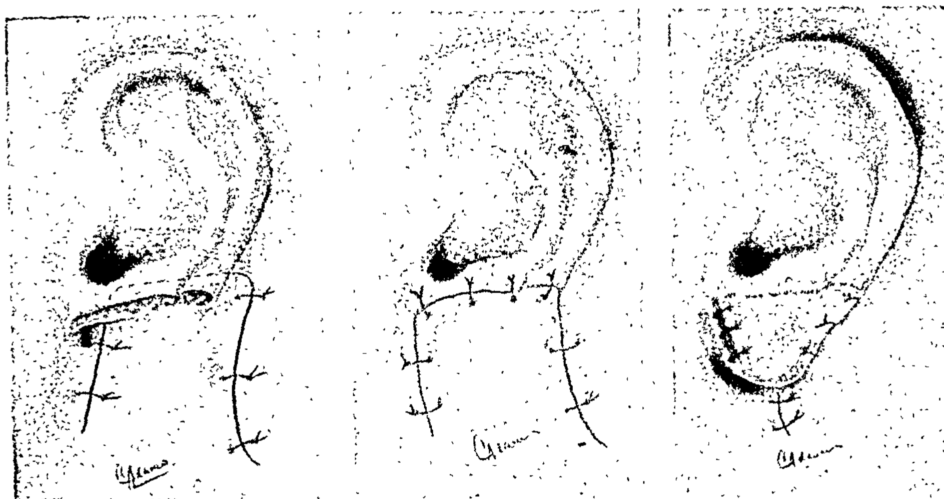


Fig. 156.—Construction of the lobule. *Left,* rectangular flap based on the neck is incised and delayed; *middle,* flap is sutured to the external skin border of the defect; *right,* base of flap is excised, folded on itself, and sutured to the skin margin of the defect on the mesial surface; borders shaped and sutured.

Stage 3.—The interval between Stages 2 and 3 is three weeks.

Trim the borders of the lobule to the desired shape and approximate with interrupted horsehair sutures (Fig. 156, *right*).

RECONSTRUCTION OF LOBULE (GAVELLO)

Procedure

Stage 1.—Outline a flap one-third larger than the required lobule, having a base AF on the skin of the cheek and neck (Fig. 157). Incise the straight line, AB, along the border of the defect of the ear, to connect the ends of the outlined flap. Incise and elevate flap D and the posterior half of flap C. Undermine the skin of the base AF. Return this flap to its bed and delay it three weeks.

Stage 2.—An interval of three weeks is allowed to elapse between Stages 1 and 2.

Again incise the line AB, the lower border of the flap D, and the posterior half of flap C (to the point F). Undermine flap C and the

tissue bordering the line AF. Fold flap D on to the mesial surface of flap C and suture its upper edge, EB, to the skin bordering the defect on the mesial surface of the ear. Suture the superior edge of flap C (AE) to the skin margin of the defect on the external surface of the ear.

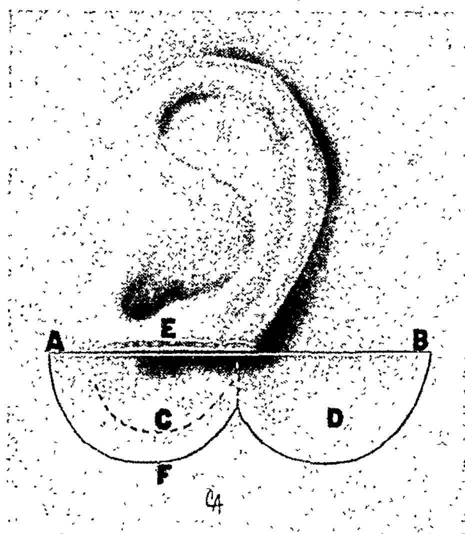


Fig. 157.—Reconstruction of the lobule (Gavello). Letters on the face of the drawing are explained in the text.

Stage 3.—The interval between Stages 2 and 3 is three weeks.

Incise the line AFE. Reduce the lobule flaps to the desired size and approximate their margins with interrupted horsehair sutures.

TOTAL AND SUBTOTAL LOSS OF EXTERNAL EAR

Requirements for Cartilage

The total or large partial reconstruction of an ear has been, until recently, the most unsatisfactory procedure in plastic surgery. The qualities of the tissues involved and the contours required for this reconstruction seemed to preclude its successful accomplishment. The normal ear is thinner than two approximated layers of the average skin of the body. The total thickness of the ear is less than that of a piece of costal cartilage which will permit of carving, and shaping and still retain its form. The best ear constructed from these tissues is bulky and lacks conchal contours and lines. It has only a general shape to recommend it.

Source of Cartilage

The researches of Kirkham determined not only that heterogeneous elastic cartilage can be employed as certainly as rib cartilage,

but that it can be taken long after death, preserved, and utilized. This makes total ear cartilage available as a proper scaffold for a reconstruction and does much to solve the problem. O'Connor and Pierce have contributed a method of preserving cartilage. Pierce utilizes struts of this material to accomplish very acceptable reconstructions of large partial losses. Greeley has utilized maternal ear cartilage, after the plan of Gillies, to produce an ear of pleasing appearance.

Preparation

The cartilage from severed portions of an ear should be stripped of soft parts, thoroughly washed in merthiolate, and planted under the patient's skin until reconstruction can be undertaken.

ATRESIA OF EXTERNAL CANAL AND SUBTOTAL LOSS OF EXTERNAL EAR

In the case which comes to mind in this connection, the injury was caused by a chemical burn.

The canal can be reconstructed by utilization of *bordering skin flaps* or by application of a *skin graft over a mold,* after dissection of the scar. The scarred, epithelial surface of a burned area is usually useless for formation of a flap for a long period of time after healing of the burned surface has occurred. If such flaps are employed early, they usually melt away promptly after transference and result in increase of the scar and contraction in the repaired area.

Procedure for Reconstruction of Canal by Skin Grafting Over Mold

Prepare the external surface scrupulously. Dissect the scar tissue and the underlying subcutaneous tissue until the canal obtained is two or three times the desired size. Make a mold of sterile modeling compound to fit cavity. Cover the mold with a single piece of intermediate split skin, raw surface outward. Insert the device in the prepared cavity. Dress with gauze and a firm bandage.

Remove the dressing and mold in six to eight days. Dry the cavity in the air and reinsert the mold. This dressing is continued at intervals until the graft has become thoroughly organized. It is wise to continue the use of an obturator for several weeks. A piece of hard-walled rubber tubing answers this purpose. This should be removed for short periods at frequent intervals to prevent maceration of the grafted skin (Fig. 158, *a*).

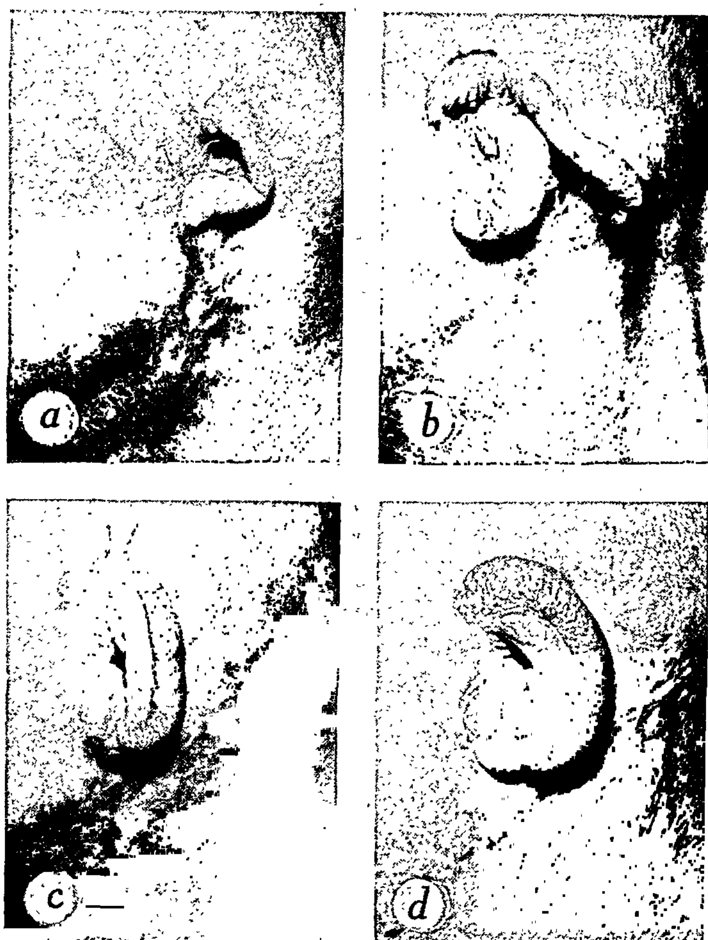


Fig. 158.—Total loss of the helix, partial loss of the auricle, and atresia of the external canal. *a*, Reconstructed ear canal; *b*, construction of the auricle with hairless scalp from the mastoid region; attachment of a pedicle from the neck to replace the helix; *c*, complete distribution of the pedicle from the neck on the auricle; *d*, result of this reconstruction two months later.

UNDESIRABLE PROCEDURE FOR RECONSTRUCTION OF EXTERNAL EAR

This case is presented to demonstrate the result obtained from utilizing the skin of the borders of the defect for construction of an auricle over carved rib cartilage and construction of the helix from a tubed pedicle taken from the neck. This cartilage is necessarily thick to permit of carving and shaping and to prevent ultimate distortion. All of the surrounding tissues consist of deep scar and scarred epithelial covering (Fig. 158, *b*, *c*, *d*).

The end-result is not good. The constructed ear is several times thicker than normal, and the soft coverings sag of their own weight. The ear has little to recommend it other than a general shape and a

patent external canal. Much could be done with the tissues at hand to improve the result, but the ear is acceptable to this patient at this stage. Such an ear is frequently acceptable to the patient but should not be satisfactory to the surgeon.

The procedures subsequently described produce a more desirable result. See page 364 for description of prosthetic restorations.

SUBTOTAL OR TOTAL LOSS OF AURICLE AND HELIX

METHOD I

In the method illustrated in Fig. 159, reconstruction is made over a preserved, homologous ear cartilage.

In this procedure, described by Kirkham, ear cartilage which is obtained in the morgue and preserved for a long period is employed. The cartilage is hardened by soaking in formalin solution for two or three days, is thoroughly washed, and is preserved in an aqueous solution of merthiolate (aqueous merthiolate in physiologic saline solution 1: 4). Kirkham's researches with animals, and his subsequent observations on human beings, demonstrated that this cartilage remains unchanged after many months. The cartilage forms a perfect scaffold for support of the soft tissues and produces a normal shape and much of the desired contour.

Procedure

Stage 1.—Make a curved incision, AB (Fig. 159, *4*), in the hairline about the periphery of the proposed ear. Separate the scalp from the underlying temporal fascia. Perforate a selected ear cartilage in numerous places to permit formation of scar between the soft parts on each surface of the cartilage and thus provide fixation (Fig. 159, *4*, C). Insert the cartilage into the scalp pocket, in the proper location for the new ear. Close the incision with interrupted sutures and apply a firm dressing. Prepare a tubed pedicle with its base over the tip of the mastoid process and of sufficient length to cover the periphery of the ear. This tube should not exceed ⅜ inch (1 cm.) in diameter (p. 16).

Stage 2.—An interval of two months is allowed to elapse between Stages 1 and 2.

Make the incision DE through the scalp to outline the border of the auricle of the new construction (Fig. 159, *4*). Dissect the included flap and cartilage to leave soft tissue on the mesial aspect of the cartilage (Fig. 159, *5*). Mold sterile dental modeling compound to the back of the ear and the defect in the scalp. Cover this mold with

thick, split skin, raw surface outward, and return it to its bed. Dress the ear with fluff gauze and a firm bandage. Remove the dressing and the mold after eight to ten days. Dry the graft in the air, return the

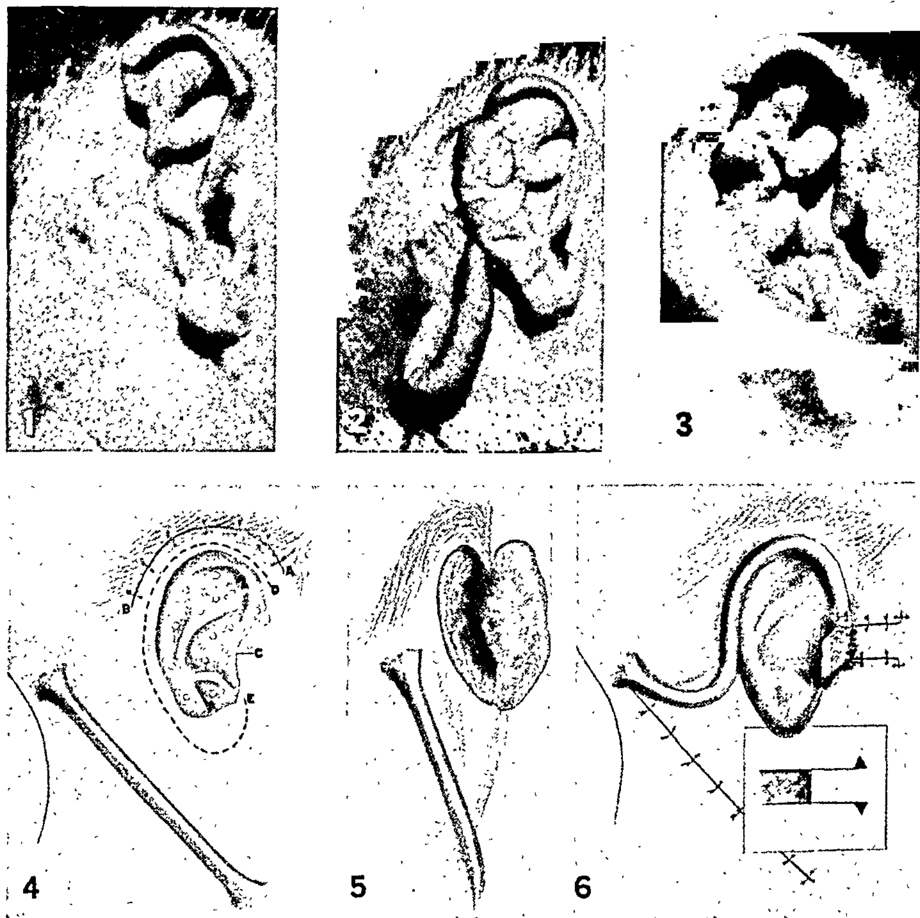


Fig. 159.—Subtotal loss of the auricle and helix. *1,* Shaped, preserved cartilage planted on the border of the defect in the mastoid region; *2,* tubed flap transplanted to the edge of the reconstructed ear; *3,* tubed flap arranged to form the new helix; *4,* AB, incision for implantation of cartilage through hair-bearing area of scalp; C, implanted aural cartilage; DE, outline of auricle; line of incision for second-stage operation; *5,* the ear has been incised along the line DE and reflected forward with the implanted cartilage attached; the raw surface on the ear and the scalp is covered with split skin; *6,* the distal end of the tubed flap is draped over the anterior and superior surfaces of the helix; a rectangular skin flap is folded on itself and sutured to form a new tragus; a sliding flap from the face closes the resulting defect in the skin (Kirkham, H. L. D.: Ann. Surg., May, 1940. J. B. Lippincott Co.).

mold, and reapply a dressing with moderate firmness. Repeat this dressing at intervals until the graft is thoroughly organized.

Stage 3.—An interval of three to four weeks elapses between Stages 2 and 3.

The inferior end of the tubed pedicle is transplanted to the anterior inferior limit of the helix, on the edge of the auricle. The scar line of the pedicle is opened for part of its length, and this portion of the tube is draped on the periphery of the new ear (Fig. 159, *6*). Construction of a tragus is begun at this stage. A rectangular skin flap, with its base in the position of the tragus, is raised from the skin of the face, folded on itself, and its edges are approximated with interrupted sutures of horsehair. The defect in the skin of the face is closed by a sliding flap (Fig. 159, *6*). Kirkham raises this flap from the conchal surface of the ear for the purpose of increasing the depth of the concha. The defect in the skin is covered with a thin, split graft.

Stage 4.—The interval between Stages 3 and 4 is three weeks.

The remainder of the tubed pedicle is opened and adjusted to the auricle to complete the helix.

Result

The reconstruction pictured in Fig. 159 presents all the elements of a perfect repair. Readjustment of the helix and removal of the depressed scars in the auricle would provide a most satisfactory result. The patient was satisfied and did not present himself for completion of the work.

METHOD II

The method to be described here consists in reconstruction with the bordering hairless skin, rib cartilage struts, and a tubed pedicle for restoration of the helix. This is the method of Pierce (Figs. 160, 161). He utilizes either autogenous cartilage or preserved homologous cartilage for this purpose. He constructs his tubed pedicle at the base of the neck, along the upper border of the clavicle, to avoid visible scars on the neck. He advances the pedicle, caterpillar-fashion, to its position on the auricle.

Procedure

Stage 1.—Make a pattern of the normal existing ear for the reconstruction. Mark the borders of this pattern on the hairless skin about the ear canal.

Make a number of short incisions, A, about the periphery of the proposed auricle. Make pockets by undermining between the scalp and the temporal fascia down to the firm attachments about the canal (Fig. 160, *5*, A). Insert thin strips of rib cartilage the length of these pockets. Close the incisions with horsehair sutures. Apply a firm gauze dressing. Prepare a tubed pedicle ⅜ inch (1 cm.) in diameter and 6 inches (15 cm.) in length from the skin of the base of the neck

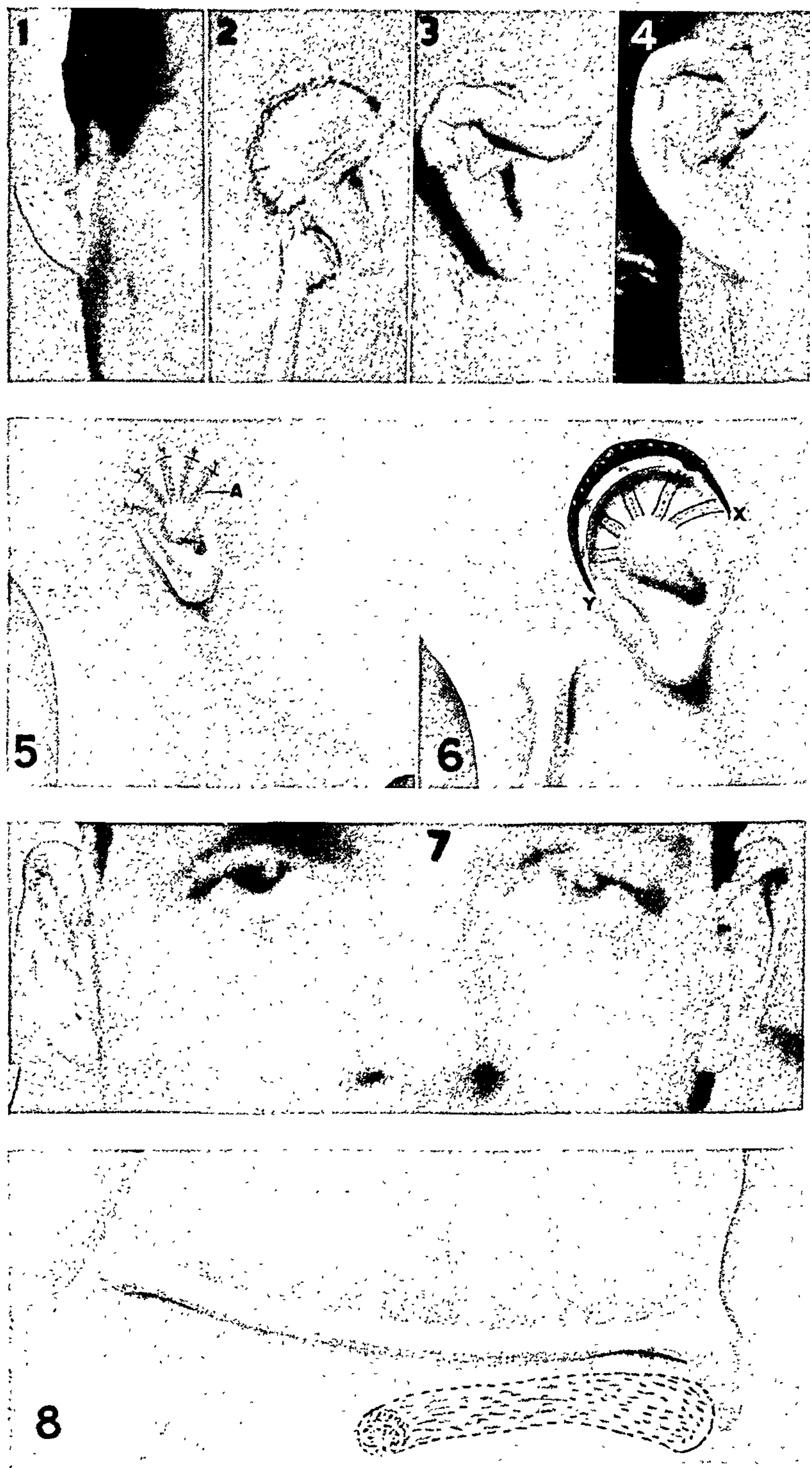


Fig. 160.—Subtotal loss of the auricle. *1*, Traumatic loss of upper half of ear; *2*, shaped cartilage has been implanted under the scalp; mesial surface of this cartilage and raw area of scalp have been covered with split skin applied over a mold; one end of the tubed flap has been transplanted beneath the lobule;

bordering the clavicle (p. 16 and Fig. 160, *8*). This will be advanced, caterpillar-fashion, to the rim of the new auricle.

Stage 2.—The minimal interval between Stages 1 and 2 is four weeks.

Make the incision XY through the scalp, around the periphery of the auricle of the proposed construction (Fig. 160, *6*). Elevate the scalp and cartilage struts, leaving soft tissue on the mesial surface of the cartilage. Mold sterile dental modeling compound into the pocket thus created, cover it with split skin, raw surface outward, and reinsert the mold (Fig. 160, *2, 3*). Close the edges of the scalp with interrupted sutures of horsehair. Apply a firm dressing for seven to ten days. Transfer the median attachment of the tube to the region of the tip of the mastoid process (Fig. 160, *2*).

Stage 3.—An interval of ten days is allowed to elapse between Stages 2 and 3.

Open the incision in the scalp and remove the mold. Dry the graft in air and reinsert the mold. Apply a moderately firm dressing. Repeat this dressing at intervals until the graft has become thoroughly organized.

Stage 4.—The interval between Stages 3 and 4 is one month.

Transfer the new inferior attachment of the tubed pedicle to the location of the anterior inferior position of the helix. Open the scar of the line of incision in the tube for part of its length and drape it on the superior surface of the helix (Fig. 160, *3*).

Stage 5.—An interval of three weeks passes between Stages 4 and 5.

Amputate the mastoid attachment of the tubed pedicle. Open the scar along its line of incision and complete its arrangement on the border of the helix.

Comment.—The various stages of the reconstruction for partial loss are pictured in Fig. 161. These stages of repair are followed in the reconstruction for either partial or total losses. The very acceptable result of this reconstruction is pictured in Fig. 161, *5*. The lobule of the ear, in a case of total loss, can be constructed from the tubed

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3, end of tubed flap pictured in *2* has been sutured to superior end of normal helix; *4*, the tubed flap is draped over edge of reconstructed auricle; *5*, A, cartilage struts have been implanted radially beneath skin of scalp; *6*, the incision XY, outlining the shape of the reconstructed auricle, connects the stab incisions noted in *5;* the skin and cartilage are reflected forward, and the resulting raw surface is grafted with split skin applied over a mold; *7*, the reconstructed ear; *8*, location of the original tubed flap above the clavicle at the base of the neck (Pierce, G. W.: Surg., Gynec. and Obst., March, 1930).

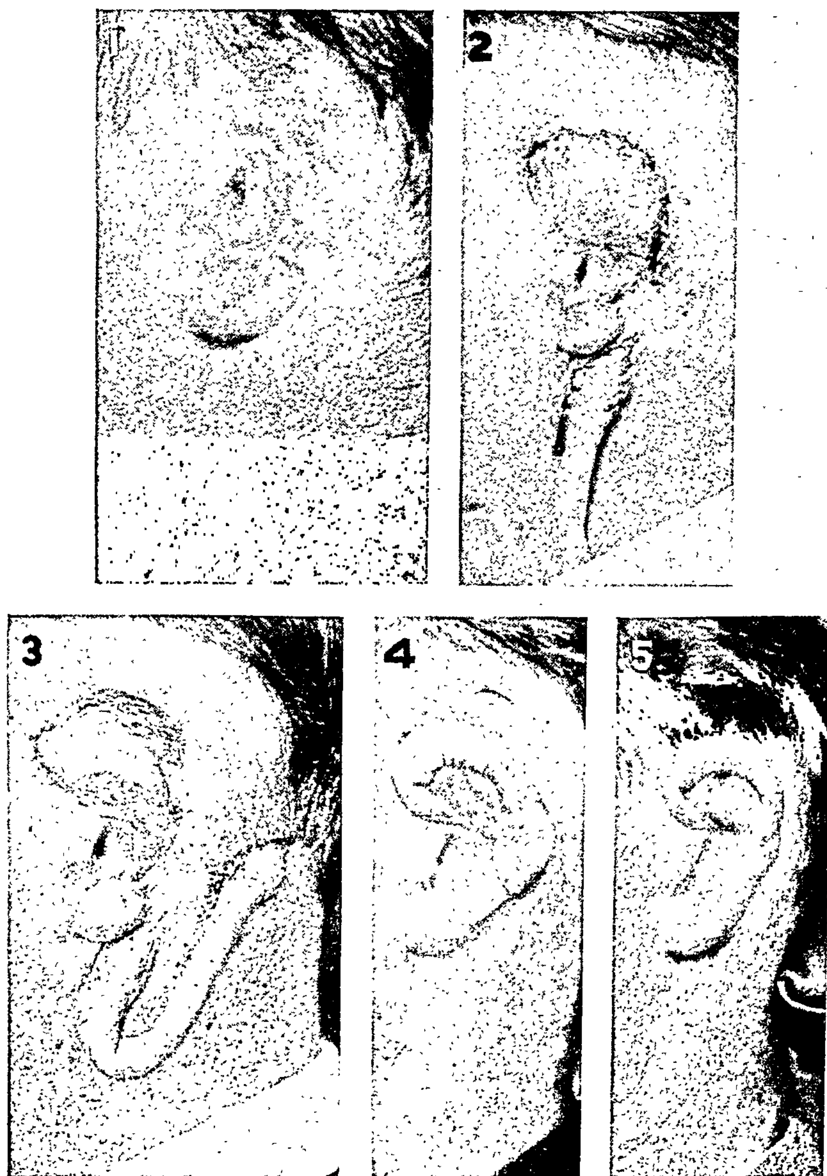


Fig. 161.—Total loss of auricle. *1,* Loss of entire ear excepting lobule and tragus; *2,* the scalp flap and cartilage have been reflected outward and resulting raw surface covered with split skin applied on a mold; the anterior end of the tubed flap has been transplanted below the lobule; *3,* the mold has been removed from behind the ear; the skin graft is in a state of organization; the posterior end of the tubed flap has been transplanted to the mastoid region ("caterpillared"); *4,* the tubed flap has been draped around the margin of the reconstructed auricle; *5,* cosmetic corrections have been made in the helix and auricle (Pierce, G. W.: Surg., Gynec. and Obst., March, 1930).

pedicle or after the plan of Gavello (Fig. 157). Construction of a tragus is pictured in Fig. 159, *6.*

ABSENCE OF ALL OF EAR EXCEPT LOBULE (CONGENITAL MICROTIA)

Requirements

External and mesial covering skin and cartilage supporting tissue.

In the reconstruction a tubed pedicle based on the shoulder and shaped autogenous cartilage are used. Preserved, instead of autogenous, cartilage can be employed. The repair which is in mind at present was effected before the present conception of total and partial otoplasty.

Procedure

Stage 1.—A pedicle is tubed on the arm as described in Fig. 6 and is transferred to the side of the head. A dressing such as is depicted in Fig. 10 is employed.

Stage 2.—The interval between Stages 1 and 2 is four weeks. The pedicle is excised at the shoulder, and the defect in this region is repaired. The attached end of the pedicle is opened along its line of union and dissected flat to supply the external and mesial covering skin of the ear. The balance of the pedicle is discarded (Fig. 158, *b*).

The piece of autogenous or preserved cartilage is properly carved to produce the general contours of the required ear and introduced between the two layers of skin (Fig. 162). The incision about the helix of the ear is closed with horsehair sutures. A rectangular flap of sufficient width to produce a small tube is outlined in the hairless skin posterior to the reconstructed ear. This extends from the top of the ear downward for sufficient length on the neck to produce a tube which will cover the entire helix of the ear (Fig. 162, *c*, *d*). The superior and inferior attachments of this flap are not incised. The flap is elevated from its bed and resutured in position (delayed). A layer of gauze is placed over the ear, and cotton is packed on this to approximate the skin and the carved cartilage. Several layers of fluff gauze are placed on the cotton and the incised flap, and a firm bandage is employed for ten to twelve days. The superior half of the previously incised flap is elevated from its bed, and its margins are sutured to form a pedicle (Fig. 162).

Stage 3.—The interval between Stages 2 and 3 is one month. The tubed portion of the flap is excised from its superior attachment. The scar line around the upper half of the helix of the ear is incised. The scar line of the upper portion of the tubed pedicle is excised, and the freshened margins are slightly dissected on each side.

These margins of the tubed pedicle are sutured to the freshened edges of the helix of the ear (Fig. 162, *e*). A part of the outlined rectangular

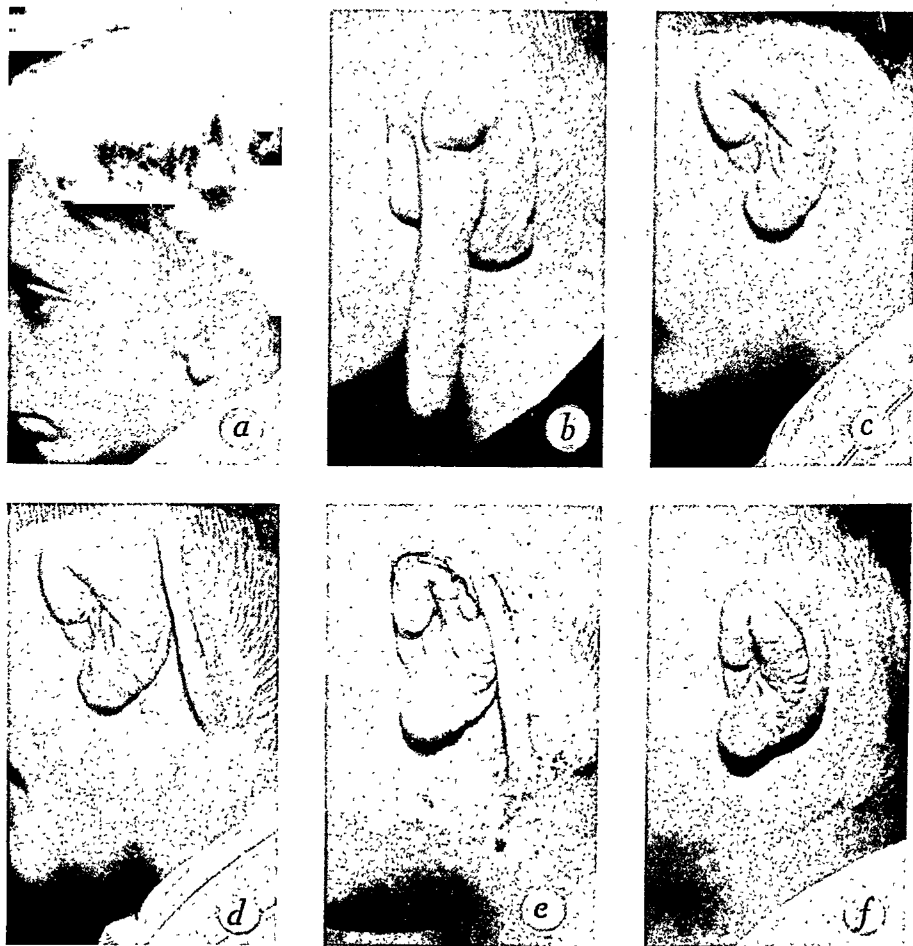


Fig. 162.—*a*, Total absence of the ear, excepting the lobule (congenital microtia); *b*, distal end of the tubed pedicle from the arm attached to the scalp in the region of the ear; *c*, shaped cartilage (autogenous or preserved) introduced between the two layers of the tubed pedicle; a rectangular flap to produce the rolled margin of the helix has been incised on its lateral borders, elevated, and resutured to its bed (delayed); *d*, the upper half of the rectangular flap has been tubed and the resulting defect in the scalp closed by sliding and suturing the borders; *e*, the scar around the upper half of the helix has been opened; the line of union of the upper half of the tubed pedicle has been incised and its borders dissected slightly; the raw edges of the tubed pedicle and those of the skin about the helix have been approximated with horsehair sutures; the rectangular flap has been sutured to form a pedicle (Fig. 158); the rest of the tubed pedicle has been draped around the remainder of the helix; *f*, result.

flap at the inferior end of the tubed pedicle is raised and tubed. A fluff gauze dressing is applied with moderate pressure.

Stage 4.—There is an interval of one month between Stages 3 and 4.

The remainder of the tubed pedicle is incised from its inferior attachment and draped around the remainder of the helix, as has been described.

Comment.—This *procedure is not one of choice* but may become one of necessity in the event of destruction of the hairless skin about the ear. The entire ear can be constructed on the distal end of the tubed pedicle flap on the arm and transferred to the head when completed.

RECONSTRUCTION OF TOTAL EAR

Immediate transfer of homologous cartilage was made from a living donor. This is a procedure described by Gillies. The result pictured in Fig. 163 is presented by courtesy of Dr. Paul Greeley.



Fig. 163.—*Left,* infant with congenital microtia; only the lobule is present; *middle,* the result of transplantation of maternal ear cartilage beneath an outlined hairless temporomastoid flap, subsequent reflection of this flap and cartilage forward, and grafting of the raw surfaces with split skin over a mold; *right,* appearance of the healed ear of donor after removal of the cartilage (Greeley, P. W.: Surgery, Sept., 1941. C. V. Mosby Co.).

Procedure

Stage 1.—Outline the pattern of the proposed ear on the hairless skin of the temporomastoid region at the same level as that of the existing, opposite ear. Outline a Gavello flap for the lobule (Fig. 157). The lobule was present in the case pictured in Fig. 163. Greeley has suggested use of a pedicled flap from the neck to construct a lobule, but this adds scar which can be avoided. Incise the scalp to the fascia outside this outline sufficiently (3 or 4 mm.) to allow for the nar-

rowing which occurs as the skin becomes molded to the cartilage. Elevate the flap. Effect complete hemostasis.

Obtain the cartilage from the donor's ear. Make an incision on the mesial aspect, around the helix, and carefully separate the skin and perichondrium from the cartilage. Replace the removed cartilage with a carved piece of preserved cartilage (author). Close the skin with interrupted horsehair sutures. Place a shaped gauze dressing behind the ear. Place a single layer of gauze over the external surface of the ear and fill all cavities with cotton. Cover with fluffed gauze and a firm bandage. The ear will retain much of its normal shape. Insert the cartilage under the scalp flap of the recipient. Approximate the line of incision with interrupted horsehair sutures. Apply a firm dressing as has been described above. This dressing should be maintained until danger of collection of serum has passed (ten days).

Stage 2.—The minimal period between Stages 1 and 2 is six weeks.

Reopen the incision in the scalp. Elevate the included flap and cartilage as one layer. Make a mold of the raw portion with sterile dental modeling compound. Cover with a single piece of split skin, raw surface outward. Insert the mold (Fig. 161, *2, 3*). Dress with gauze and a firm bandage and continue to employ the dressing for seven to ten days. Remove the mold. Dry the graft in air and replace the mold and dressing. Repeat at frequent intervals, until the graft has become thoroughly organized. Complete construction of the lobule (Fig. 157).

A tragus can be constructed as pictured in Fig. 159, *6*. A small bit of cartilage can be used in this construction, if required.

Prosthesis

It may be desirable, under certain circumstances, to replace the lost part with a prosthesis rather than to undertake a reconstruction. An excellent ear can be molded with latex, which contains basic color, or with one of the acrylic resins. The ear can be tinted to match the surrounding skin. Construction of these prostheses is discussed on page 370.

CHAPTER VIII

DEFECTS OF SCALP AND CRANIUM

DEFECTS of the scalp are best repaired by *flaps* obtained from the borders of the defect, when ample material is available. Little can be gained by undermining and stretching the scalp except in the anteroposterior direction. Scalp has no elasticity of practical value. This can be increased materially by incising the galea in parallel transverse lines. Consequently, only small defects can be closed by sliding and approximating the margins of the defect. Only those flaps which are rotated or interlaced, or both, can gain advantage from the slight movability of the scalp. Adequate relaxation incisions permit frequently greater shifts of scalp. The defect created heals by granulation. Defects of any considerable size can be repaired with *flaps of split skin*, which are applied immediately in the presence of a clean pericranium or after the growth of a granulation bed on denuded bone (p. 55). Such a granulation bed is produced by drilling to the diploe at frequent intervals and dressing with potassium chloride (0.65 per cent) to stimulate growth. *Tubed pedicled flaps* can be "caterpillared" from the posterior or anterior surface of the thorax for this purpose (Fig. 160, *2, 3, 8*). (For anesthetic procedures, see Section IV.)

Bone, Cartilage

Losses of the skull are best replaced with bone, but they can be bridged and protected by strips of implanted cartilage. Cartilage does not unite with bone but is simply encapsulated in position to furnish a protective covering and restore contour. Small defects of contour also can be corrected with implanted dermal grafts (p. 23). Bone for repair of these defects can be obtained from the ilium or the tibia and can be utilized either as a *block* or as an *osteoperiosteal graft* (p. 20). The latter is the graft of choice. Metal plates of any type are foreign bodies and should not be employed.

LOSS OF BONE WITH INTACT SCALP

Procedure

Make an incision to the periosteum to outline a flap including a blood supply, about $\frac{3}{8}$ inch (about 1 cm.) from the bony border of the defect. Separate and elevate the included flap. Separate and re-



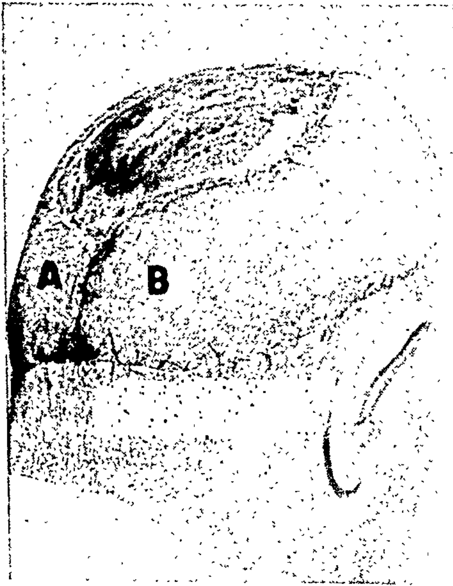


Fig. 164.—Cranial loss without defect in the scalp. *Above,* loss of the supra-orbital ridge, frontomalar process, and surrounding frontal bone; loss of the eyeball, tissue from the upper lid, and a portion of the auricle and helix; *lower left,* the same; *lower right,* result of reconstruction with an osteoperiosteal graft inserted beneath a scalp flap including the supra-orbital artery in its base.

tract the periosteum to the edge of the incision in the scalp. With a chisel or a burr freshen the cortex of the bone from its free edge to the periosteal attachment. Cut sufficient osteoperiosteal graft from the tibia to cover the defect. Cut it into proper lengths (pp. 20, 304). Place the strips across the defect so that their bony surfaces rest on

the freshened cortex. Draw the cranial periosteum over the periosteal surface of the graft. Close the scalp with interrupted sutures. Apply a





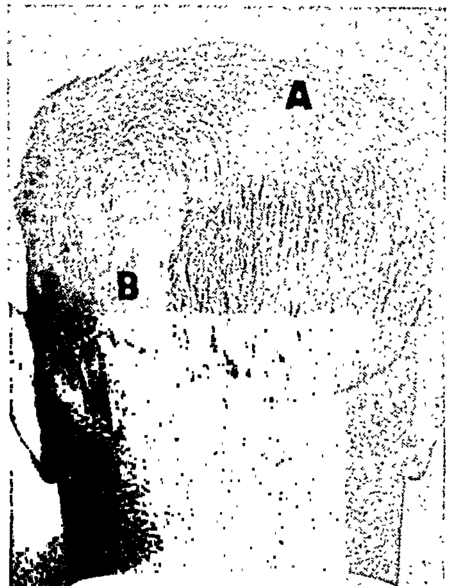


Fig. 165.—Loss of cranium and scalp. *Top,* loss of scalp and parietal and occipital bone; exposed dura presenting suppurating granulation (suppurative pachymeningitis); *lower left,* cleanly granulating dura; exposed edges of bone; delayed flaps of scalp (AB) for the reconstruction; *lower right,* skull repaired with osteoperiosteal graft; defect of scalp repaired with rotated flaps A and B.

gauze dressing with a firm bandage. Fig. 164 pictures the result of such a repair.

LOSS OF BONE AND SCALP

The patient represented in Fig. 165 presented a large loss of bone in the parietal-occipital region with suppurating pachymeningitis (Fig. 165, *top*).

Procedure

Stage 1.—Flaps A and B (Fig. 165, *lower left,* and *lower right*) were incised on the lateral borders of the defect after the infection had been controlled and the dural surface was clean. Each flap contained the posterior branch of the ipsilateral temporal artery in its anterior and middle portions. The principal arterial supply of the posterior portion of the flap is sectioned by the incision. Each flap was consequently elevated and returned to its bed on several occasions before it could be rotated without danger of distal loss.

Stage 2.—An interval of eight weeks was allowed to elapse between Stages 1 and 2.

Flaps A and B were separated from the underlying pericranium. Their superior borders and the borders of the defect were freshly incised, and the distal end of flap A was rotated to suture to the anterior border of the defect. Flap B was rotated under flap A and was stretched as far to the left as possible (Fig. 165, *lower right*). Note the lateral excursion of the distal ends of these flaps from the midline. The superior edge of flap B approximated, and was sutured to, the inferior margin of flap A. The remaining defect between the lower border of flap B and the skin of the neck was closed by freely undercutting the skin and subcutaneous tissues of the back of the neck and sliding them to approximate the edge of flap B. A moderately firm dressing of gauze and a bandage were applied.

Stage 3.—The interval between Stages 2 and 3 was three weeks.

The scars in the scalp were opened to uncover the bony edges of the defect, and the defect was repaired with osteoperiosteal strips, as described.

CHAPTER IX

CERVICOPLASTY

SCAR CONTRACTION (FOLLOWING BURN)

IN THE case on which the next few paragraphs are based, the curve of the neck was obliterated. There were also atrophy and maldevelopment of the mandible, limitation of movement of the head, and slight ectropion of the lip. Reconstruction was by Z plastic operation, implantation of cartilage in the mental region, and implantation of a dermal graft to restore contour and motility to the soft parts of the chin and lip (Fig. 166).

It is presumed that proper care of the casualty from the time of injury or burn, until repair is completed, would preclude this ultimate deformity. It may result, however, from loss of bone of the mandible, loss of the surface and infection in the neck, and may demand the attention of the surgeon.

Several surgical procedures are described. (For anesthetic procedures, see Section IV.)

Procedure

Stage 1.—Design a Z flap with the central member of the Z splitting in linear fashion the midline of the scar fold which extends from chin to clavicle. Cut the lateral members of the Z at an angle of 60 degrees with its central member (p. 38). Make two such lateral flaps on each side of the central member. Elevate the triangular flaps included between these incisions. Freely undercut the skin and subcutaneous tissue about their bases. Obtain complete hemostasis. Transpose these flaps and suture the points of the upper flaps as far laterally as possible to produce a chin line. Adjust the edges of the skin and approximate them with interrupted horsehair sutures. Dress with gauze and firm bandage. Remove all of the stitches, except those at the points of the transposed triangles, on the second day. Support with strips of gauze applied with collodion.

Stage 2.—A minimal interval of one month is allowed to elapse between Stages 1 and 2.

Excise the scars bordering the upper transposed triangles. Dissect and elevate the included flaps and the bordering skin and subcu-

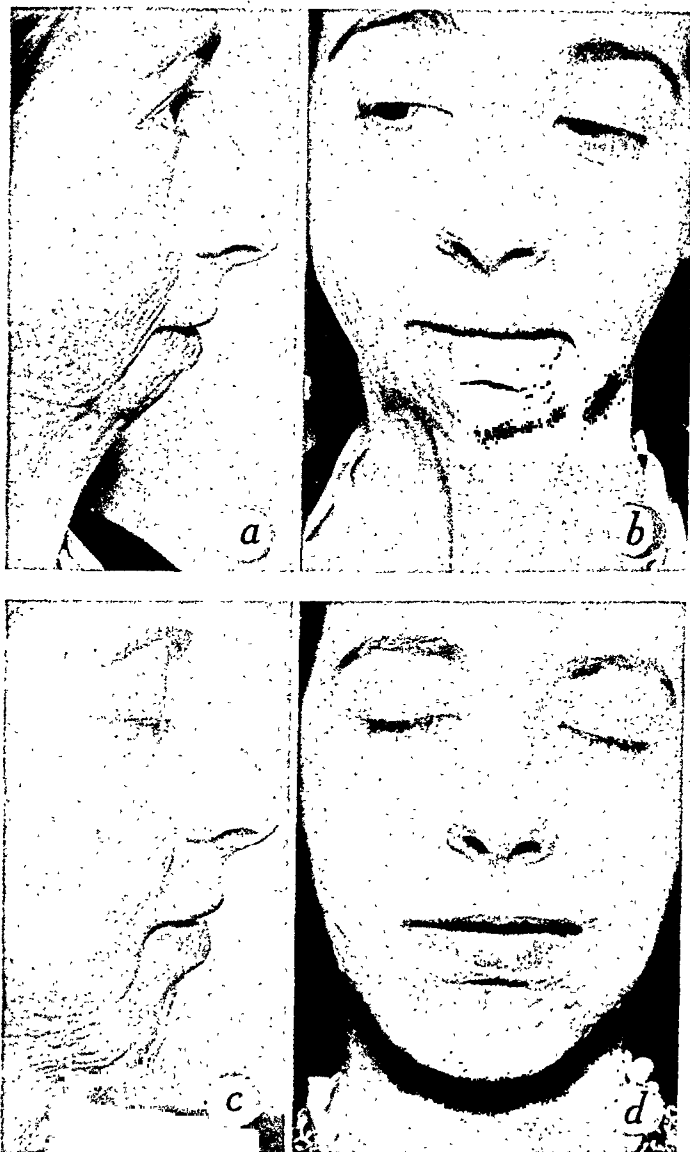


Fig. 166.—Contraction caused by cervical scar. *a* and *b*, Contraction caused by cervical scar obliterating the neckline, limiting the motion of the head, and resulting in atrophy and maldevelopment of the mental portion of the mandible; *c* and *d* (patient used face powder for these photographs), the result of *Z* plastic operations on the neck; scar removal from lower lip; cartilage and dermal graft to the mental area of the mandible.

taneous tissue. Draw the points of these flaps as far laterally as possible without impairing their blood supply. Mark the contact of these points on the surrounding skin of each side and open the skin

to this point. Suture the points of the flaps in these newly created angles and close the approximating skin edges of the flaps with interrupted horsehair sutures. The remainder of the management in this stage is the same as that in Stage 1.

The purpose of elevating and extending these triangular flaps farther laterally is to increase the tension of the skin beneath the jaw and further to improve the curved line from chin to neck. It is frequently necessary to repeat this maneuver a third time in order to obtain a desired result.

Stage 3.—The minimal interval between Stages 2 and 3 is three weeks.

Next, undertake reconstruction of the mental region. Make a mask of the face. Make, with modeling material, a suitable chin on the mask. Obtain from this the dimensions and contours of the desired addition to the mental region of the patient.

Make two vertical incisions, ¾ inch (almost 2 cm.) long, beginning at the lower margin of the mandible, beneath the angles of the mouth. Extend these incisions to the periosteum. Undermine the skin and soft tissues above the periosteum, between the two incisions and up to the sulcus of the lip. Extend this undermining a short distance laterally from each incision. Shape a piece of preserved rib cartilage to the dimensions and contour obtained from the model on the mask. Insert this in the tunnel and close the incisions with interrupted sutures of horsehair. Apply a smooth, firm gauze dressing with strips of adhesive tape. Remove the cutaneous stitches on the second day. Replace the dressing at appropriate intervals for ten days.

Stage 4.—The minimal interval between Stages 3 and 4 is six weeks. Open the scars of the incisions made in Stage 3; elevate the skin and subcutaneous tissues between them without interfering with the implanted cartilage. Obtain skin for a dermal graft from a distant surface of the body (p. 23). Remove its epithelium as described on page 23. Draw either a single or double layer of the graft into the prepared tunnel. Close the incisions with interrupted stitches of horsehair. Dress and manage as for Stage 3.

SCAR CONTRACTURE AND KELOID WITH FIXATION OF CHIN TO CHEST

Reconstruction in the case under consideration was with a pedicled flap from the back. This case is an extreme example of *bad management of a third-degree burn*. The scar involved the anterior surfaces of the chest and abdomen and extended to the axillary lines.



Fig. 167.

Plan of Repair

This demanded the use of a pedicled flap to control subsequent formation of scar and to provide the desired cosmetic result. The source of this flap was of necessity the back. The dimensions of a flap to provide all of the necessary material demanded careful consideration. The defect produced by removal of a contracted scar and by retraction of its released borders never ceases to be astonishing. The defect in this instance was particularly so. A flap 6½ inches (16.5 cm.) wide was required to repair it (Fig. 167, *e*). More than half of the total width of the covering skin of the back was required. The length of the pedicle and flap must be sufficient to permit the flap to cover the defect without tension when the pedicle is swung around the neck.

Time is the friend of the surgeon in cases of this type. The longer the intervals, within reason, between the stages of reconstruction, the more certainly it will proceed. The surgeon must not be unduly influenced by the desires of the patient or by the demands of his situation.

Procedure: Preparation of Pedicle and Flap

Stage 1.—Incise the sides and distal end of a rectangular flap, of sufficient length and width, with its base on the left shoulder. Carry the incision through the skin and subcutaneous fat. Dissect the middle third of the flap free from the fascia. Freely undercut the skin and fat bordering this area. Pass two Halsted relaxation stitches (Fig. 19) of heavy catgut through the undersurfaces of the bordering skin to approximate its edges. Close with interrupted horsehair stitches. Roll the edges of the free flap together and approximate with interrupted horsehair sutures (Fig. 167, *b*). Close the line of incision around the flap with interrupted sutures of horsehair. This border incision cuts off *lateral blood supply* to the flap. Dress with gauze applied with adhesive tape.

Fig. 167.—Obliteration of anterior aspect of neck; fixation of head. *a*, Extensive hypertrophied scar and keloid obliterating the neck and fixing the chin to the chest below the clavicle; the scar covers the chest to the umbilicus and to both axillary lines; *b*, a delayed, tubed pedicled flap 6½ inches (16.5 cm.) wide, based on the shoulder and cut across the blood supply; c, the scar obliterating the neck has been excised and the head released; the tube pictured in *b* has been swung around the neck and the flap on its distal end utilized to cover the dissected portion; partial incisions in the tube at the point of ultimate amputation; the portion of the tube attached to the neck flap will be opened and utilized to complete the repair; *d* and e, end-result of this procedure; hypertrophied scar borders the transplanted flap.

Stage 2.—The minimal interval between Stages 1 and 2 is one month.

It is apparent that the flap cuts across the entire blood supply of the area. Considerable time will be required to enlarge the circulation from the base through the pedicle to, and in, the flap sufficiently to provide an adequate supply of blood. This must be accomplished by careful delaying of the flap (p. 18). Incise the borders and end of the distal third of the flap. Dissect the skin and fat from the fascia. Return the flap to its bed. Approximate the edges along the line of incision with interrupted sutures. This cuts off the *blood supply from the base and borders* of the flap and forces it to depend on circulation from above.

Stage 3.—The interval between Stages 1 and 2 is three weeeks.

A lateral half of the flap, from the end of the tube to the distal end, is treated as described under Stage 2.

Stage 4.—The interval between this and the former stage again is three weeks. The opposite lateral half is treated as described under Stage 2.

Stage 5.—Again the interval is three weeks.

The entire lower half of the flap is managed still in the same way.

Stage 6.—The interval remains three weeks.

In the case under consideration the entire flap was elevated. It enjoyed good blood supply in its normal position but became cyanosed when the pedicle was elevated. It was returned to its bed on this, and on a subsequent, occasion three weeks later.

Procedure Continued: Repair of Neck

Stage 1.—Make an incision at the junction of the scar and the skin of the cheek and chin, beginning on the right side and extending from the attachments of the scar to the skin over the mandible on the left side. Dissect the scar tissue from the area beneath this incision to release the chin. This dissection should be carried to the fascia and should completely remove the scar in the neck. Release of the mandible and elevation of the head leave the *entire neck without covering.*

Excise the borders of the scar beneath the clavicle to obtain the approximating surface for the transposed flap. Elevate the flap. Incise the median and lateral scar lines of the base of the pedicle and slightly undercut the bordering skin of the base. This will permit greater rotation of the pedicle. Swing the pedicle across the back of the neck to bring the flap into the cervical defect (Fig. 167, *c*). Tack the flap to the underlying fascia along the line of junction of

chin and neck, using a few interrupted catgut sutures. These sutures should be passed along a line in the flap which permits distribution of its upper portion over the chin without tension. This suture line is important in obtaining a pleasing chinline. Approximate the borders of the flap with interrupted horsehair sutures. Dress with gauze applied with a bandage which, in turn, is fixed with strips of adhesive tape.

The skin defect in the back, resulting from elevation of the flap, is closed by rotating appropriate skin flaps.

Stage 2.—The minimal interval between Stages 1 and 2 is one month.

The transplanted flap has acquired a considerable new blood supply during the interval, from invasion and organization of vessels about its border and its base. This flap will ultimately become the source of blood supply for that portion of the pedicle which will be amputated and opened to complete repair of the neck. Severance of the blood supply through the pedicle begins at this stage. It parallels delaying of the distal flap in the manner of building up a proper blood supply from the opposite end of the pedicle.

Determine the length of the pedicle to be utilized in completing the repair. Cut into the pedicle for a short distance on opposite sides of the proposed line of amputation (Fig. 167, c). Cover with a gauze dressing applied with adhesive tape. Repeat this procedure at intervals of ten days, until the pedicle has become completely severed. Excise the scar along the suture line of the pedicle and spread it out to complete repair of the lateral surface of the neck. Approximate its borders with interrupted sutures. Amputate the excess remainder of the pedicle and adjust its base into the surrounding skin.

CHAPTER X

LOSS OF HARD PALATE AND PREMAXILLARY PORTION OF ALVEOLAR PROCESS

TOTAL LOSS

THE condition contemplated here can be repaired with a tubed, pedicled, skin-covered flap taken from the abdomen and transferred on the wrist as a carrier.

Procedure

(For anesthetic procedures, see Section IV.) *Stage* 1.—Tube on the abdomen a pedicle of proper length, carrying a flap of the required size (Figs. 9, 168, *b*). Elevate and delay this pedicled flap at intervals of three weeks until an adequate blood supply has become established.

Incise and elevate a semicircular flap on the wrist of the arm of the side opposite to that on which the tubed pedicle is situated. Elevate the flap at the mesial end of the tubed pedicle and suture it to the borders of this skin flap on the wrist and of the defect created by its elevation (Fig. 168, *b*). Support the arm with a dressing which will prevent any traction on the tubed pedicle. Permit the arm to stay in this position until a blood supply adequate for nourishment of the lateral portion of this tubed pedicle has become established. It is usually necessary to elevate and delay this lateral portion one or two times at intervals of three weeks before it can be safely detached from the abdomen. Incise the superior and lateral borders of the flap that remains attached to the abdomen, undercut it freely, and cover its raw surface with split skin. Dress with a firm gauze dressing and continue to employ the dressing for seven to ten days.

Incise and elevate the grafted flap at the lateral end of the tubed pedicle. Split the anterior margin of the velum at the posterior border of the palatal defect. Pare the epithelium from the distal margin of the grafted flap on the tubed pedicle. Suture this, with several horsehair stitches, into the split edge of the velar border of the defect









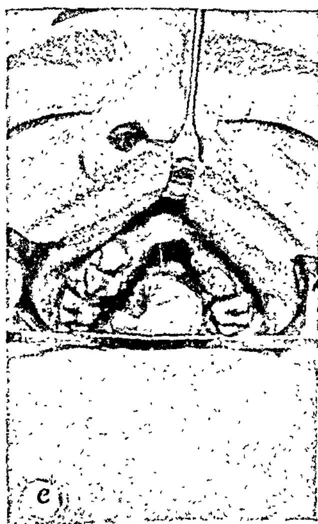




Fig. 168.

(Fig. 168, c, *d*). Fix the arm and the head with a plaster dressing, as depicted in Fig. 168, *d* (see also Fig. 10). The strips which connect the head cap to the dressing about the arm and across the back should be reinforced with a thin strip of band iron. The position of the arm and head is not only comfortable, but also safe.

Stage 2.—An interval of three weeks is allowed to elapse between Stages 1 and 2.

Excise the attachment of the pedicle from the wrist. Incise the scar line in the pedicle and dissect it flat. Dissect the scar from the lingual surfaces of the alveolar process and excise the margin of the scar of the alveolar defect in the premaxillary region (Fig. 168, *e*). Suture the anterior margin of the pedicle to the gingival tissue about the premaxillary defect. Pass two or three sutures through the lateral margins of the pedicled flap. Tie these around the adjacent teeth. Pass two or three interdental wires across the palate to support an iodoform gauze pack which will approximate the raw surfaces of the flap and the freshened alveolar surfaces. This dressing remains in place for five to seven days, at which time it is replaced. The stitches are removed in ten days. The final repair is pictured in Fig. 168, *f*.

Prosthesis

It is the common practice to furnish a prosthesis to correct these defects. If the losses are very extensive (loss of alveolar process, half of the palate, anterior maxillary wall, and so forth), a functional reconstruction appears to be impossible. It is the conviction of the author, however, that losses of the palate and alveolar process can be reconstructed successfully. The soft parts may be reconstructed first, as in this case, and any essential bone supplied later, or the bone may be included in the prepared flap and its freshened borders approximated to similar surfaces of the defect after an interval sufficient to establish good blood supply in the transplanted soft tissues. (See "Maxillofacial Prosthesis," Section III.)

Fig. 168.—Loss of hard palate and premaxillary portion of alveolar process. *a*, Total loss of palatal bones and of alveolar process at site of central teeth (premaxilla); nasal oral fistula; *b*, one attachment of a tubed, pedicled flap transferred from the abdomen to the left wrist; c, skin-covered tubed, pedicled flap, with arm utilized as a carrier, sutured into the velar margin of the palatal defect; *d*, plaster dressing reinforced with steel straps for fixation of head and arm in a safe, comfortable position (author); *e*, flap united with free margin of velar border of palatal defect; pedicle amputated from wrist; *f*, tubed pedicle has been opened along its line of union and dissected flat; raw surfaces of border of this flap have united with freshened surfaces of bone on lingual aspect of alveolar process; anterior margin is united with freshened borders of gingival defect.

SECTION II

MAXILLARY SURGERY

Leigh C. Fairbank, Brigadier General, Medical Department, U. S. Army
Roy A. Stout, Lieutenant Colonel, Dental Corps, U. S. Army
Robert H. Ivy, Colonel, Medical Reserve Corps, U. S. Army
Joseph D. Eby, Formerly Lieutenant Colonel, Dental Reserve Corps, U. S. Army

CHAPTER XI

GUNSHOT WOUNDS INVOLVING JAWS

THE great majority of gunshot wounds of the facial region produce fractures of the jaw bones. The bone injury is accompanied nearly always by extensive destruction of soft tissue. These two factors should not and cannot be separated in planning rational treatment. Efficient treatment demands close *cooperation* of the surgeon and the dental surgeon. The general care of the patient, the problem of infection of wounds, and repair of tissue will be directed largely by the medical officer, while the special problems concerned with fixation of the fractures of the jaw and with their complications, together with care of the mouth and teeth, are the responsibility of the dental surgeon.

Anesthesia is necessary to reduction and fixation in many cases. Anesthetic procedures are described in Section IV.

TYPE AND VELOCITY OF MISSILE

The type and velocity of the missile have distinct bearing on the character of the wound. The civilian surgeon and dental surgeon are confronted rarely with gunshot wounds such as result from war. The problems presented are distinctly different from those met in civil life.

Bullet Wounds

The amazing velocity of the high-caliber bullet, the rotary motion of the missile, its covering jacket, and its shape and weight are responsible for the types of wounds produced. The modern bullet, traversing soft tissues, produces a tract with less contusion and laceration than the old, spherical missile. The wound of entrance has a punched-out appearance, while the wound of exit is always slightly larger. The bullet, at its highest velocity, when it strikes the jaw, commonly breaks it into numerous fragments. The actual site of fracture is clear of splinters, as a rule, for the fragments are forced into the soft tissue or out through the skin, giving the wound of exit the appearance of an explosive effect. Large masses or fragments



Fig. 169.—Bullet wounds. *Upper left,* high-velocity bullet; small opening at point of entrance; exit large and irregular; extreme comminution of bone involved; *upper right,* drawing showing course of bullet; *lower left,* wound caused by slow, tumbling bullet; missile crushing through into the maxillary sinus, lodging there; *lower right,* drawing showing bullet lodged in maxillary sinus.

of bone and particles of bone, either free or adherent to muscular and tendinous tissue, characterize the wound of exit if inflicted at short

range, by a bullet traveling at high velocity (Fig. 169). Wounds inflicted at longer range, by bullets traveling at comparatively low velocity, are considerably different from those just described. The fragments of bone are larger, fewer, and less displaced. The wound of exit in cases of fracture is always larger than when no fracture exists (Fig. 1).

Wounds Caused by High Explosives, Shell Fragments, and Hand Grenades

These wounds differ from those produced by small-arms missiles. They are always irregular, contused, and lacerated, and are complicated usually by considerable shock and the lodgment of a foreign body. The power of penetration of projectiles of this type is not great, but they are extremely destructive. The degree of laceration of the soft tissues is greater than in bullet wounds; the skin and muscles are irregularly torn, and shreds or ribbons of these tissues hang from the open wound. These lacerated wounds are usually greater in area than in depth. The soft tissues frequently are so lacerated and devitalized that they will not resume their normal relations (Fig. 1).

COMPLICATING INJURIES

Wounds of the maxillary region frequently involve the *maxillary sinus,* the *alveolar process,* the *teeth,* and the *buccal cavity.* Great destruction and displacement usually attend such wounds. The laceration is marked, especially if the wounds were caused by shell fragment, shrapnel, or pieces of grenade. Missiles penetrating the oral tissue frequently involve the tongue but seldom lodge within its substance. The impact of a high-velocity bullet on the compact structure of the mandible shatters its substance and produces corresponding injury to the soft tissues (Fig. 169). The trauma is even greater if the teeth and alveolar process are involved. Bullet wounds resulting from long-range rifle fire occasionally may gutter or perforate the mandible causing little splintering of the bone.

Fractures of the upper portion of the *ascending ramus* and of the neck of the *condyloid process* often present serious complications and result in ankylosis unless proper surgical care is given during the early stages of treatment (Fig. 187).

TREATMENT OF GUNSHOT WOUNDS INVOLVING JAW

A correlated plan of treatment, beginning with first aid in the advance zone and continuing through the hospital installations of the

zone of communication and the zone of the interior, will materially reduce the average period of disability of the casualty. Likewise, a larger number of casualties will be restored to normal functions and approximately normal appearance than if haphazard methods were followed.

FIRST-AID AND EMERGENCY TREATMENT

Hospital Installations

The *surgical hospital* is the most advanced organization to which specialists in the care of injuries of the face and jaw are attached. It is a mobile unit operated in connection with the *clearing station*, located from seven to ten miles to the rear of the front line. Each surgical hospital is provided, when called from Army Headquarters, with a maxillofacial team, consisting of a surgeon and a dental surgeon, well trained in special treatment of these casualties. The *evacuation hospital* in the same vicinity is likewise provided with maxillofacial specialists on demand.

Treatment in Combat Zones

The wounded man should receive emergency care from the company aid men and the battalion aid personnel before reaching these installations. Battalion medical and dental officers and their enlisted men have received certain instructions in the use of emergency equipment with which they are provided for treatment of injuries of the jaw. Definite procedures are specified in order that a uniform plan of treatment can be carried out at these advanced posts. Attention to these points probably will save many lives and facilitate the later treatment by the specialists of injuries of the face and jaw.

First-Aid Packets.—Every officer and soldier of the Medical Department in the combat zone is supplied with equipment for rendering first-aid treatment to casualties who have sustained wounds of the jaw. The first-aid packet is admirably adapted for treatment of wounds of these parts and of many types of gunshot injuries of the face and head. The compress, sewn to the central portion, can be made to serve as a hammock or sling to support the injured structures. The dressing becomes an ideal four-tailed bandage by tearing of the attached bandage lengthwise (Fig. 170). This can be securely and satisfactorily applied by the officer or enlisted man. The compress itself can be separated from the bandage and used as an extra packing, dressing, or support over any region where it is necessary. The safety pins in the first-aid packet assist in making the dressing more secure.

Emergency fixation can be applied with bandages, adhesive plaster, and so on, with the aid of common rubber bands or elastic bands and safety pins.



Fig. 170.—*a*, *b*, *c*, Four-tailed bandage made by using the compress and bandage contained in the Army first-aid packet; *d* and *e*, first-aid methods of bandaging for injuries of the head and jaw, using compress and roller bandage for the support of tissues and control of hemorrhage.

Emergency Measures.—The points demanding special attention in the combat zone can be formulated as follows:

1. Arrest of hemorrhage.
2. Provisions for adequate respiratory airway.
3. Temporary approximate reduction and fixation of fragments of bone.

4. Provisions for safe transportation from the combat zone to the hospital in the rear.

Treatment of shock, sedation, use of antitetanic serum,* and other general emergency measures are dealt with in Section I.

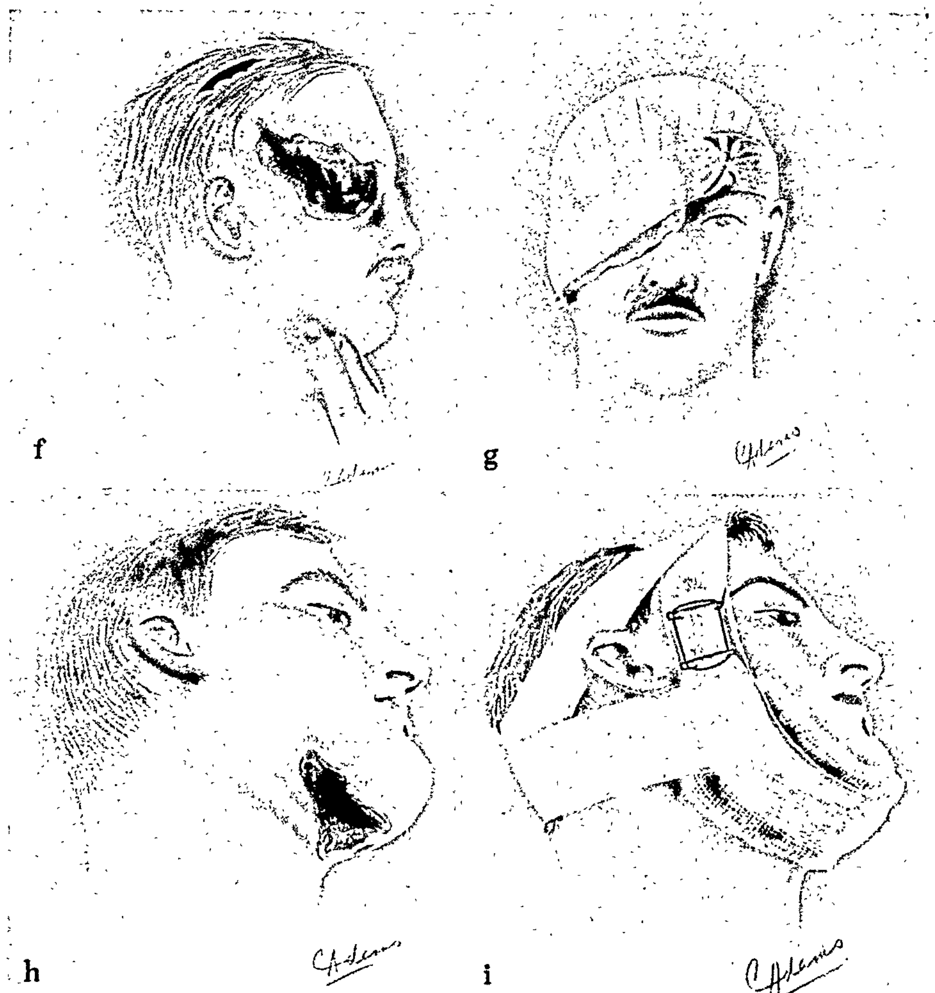


Fig. 170.—*f, g, h, i,* First-aid methods of bandaging for injuries of the head and jaw, using compress and roller bandage for the support of tissues and control of hemorrhage.

Arrest of Hemorrhage

The tourniquet cannot be used for temporary arrest of bleeding from the region of the *head* and *face*. Compression over certain points with the finger or thumb, however, may lessen profuse bleeding long enough to save life until more permanent aid is available. The carotid artery can be compressed against the spinal column with the

* Antitetanic serum not given if immunization has been effected by tetanus toxoid. See Circular Letters, Nos. 34 and 110, War Department, Office of the Surgeon General.

thumb at the level of the larynx and just within the anterior border of the sternocleidomastoid muscle (Fig. 171, D). Profuse bleeding from the face can be controlled to some extent by pressure over the external maxillary or facial artery as it crosses the lower border of the mandible, about ¾ inch (almost 2 cm.) in front of the angle (Fig.

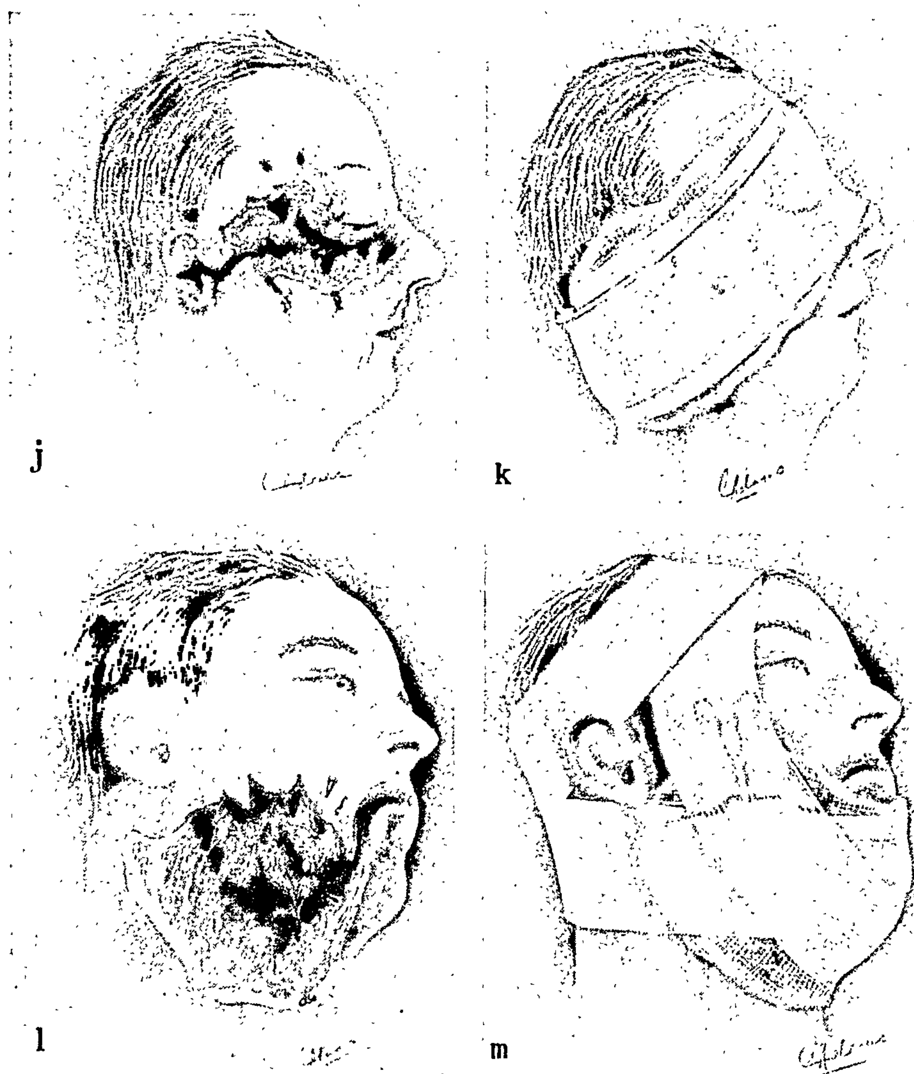
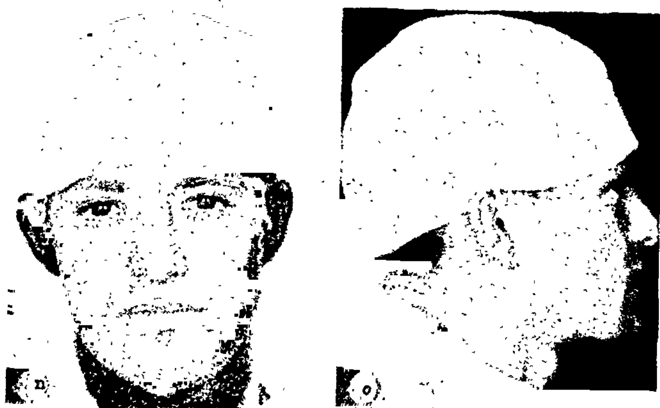


Fig. 170.—*j, k, l, m,* First-aid methods of bandaging for injuries of the head and jaw, using compress and roller bandage for the support of tissues and control of hemorrhage; *m,* shows also how an artery clamp can be included in the bandage.

171, B). The superficial temporal artery is compressed in front of the ear, just below the root of the zygomatic arch (Fig. 171, A).

Bleeding from the *tongue* sometimes can be temporarily controlled by pressing the tongue against the body of the mandible (Fig. 171, C). Pass a ligature with a curved needle through half of the tongue







170.—*n* and *o*, Recurrent head bandage; *p*, *q*, *r*, Parker bandage: one urns of gauze, over which adhesive tape is placed, with safety pins for e of elastic traction; *s* and *t*, vertical and circular roller bandage sup- nd stabilized with adhesive tape; *u*, same bandage with safety pins for e of elastic traction.

›r to the bleeding point. This should enter the dorsum and from the floor of the mouth at the side of tongue. Tie firmly ve the ends of the ligature protruding from the mouth.
derate hemorrhage from a wound about the *jaw* usually can

be checked by inserting a gauze pack into the wound and holding it in place by a four-tailed bandage. This also will give some temporary support to a fractured mandible. Care must be exercised in application of the pack and bandage so as not to increase any respiratory difficulty occasioned by the nature of the wound itself. Hemorrhage that cannot be checked in this way demands a search for the bleeding vessel and application of a clamp to it. This is followed by ligation, if ligature

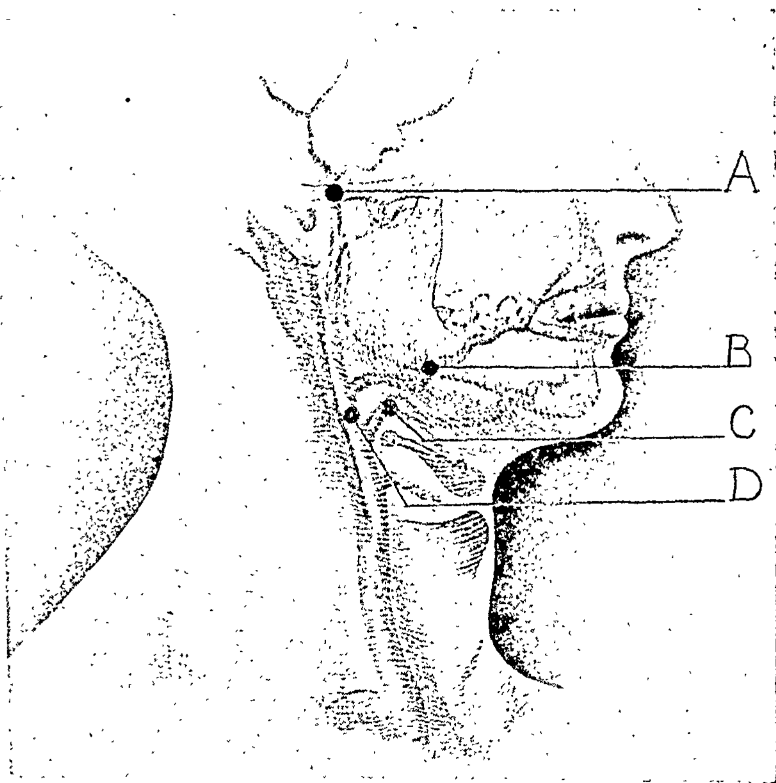


Fig. 171.—Drawing, pointing out sites for application of digital pressure to control severe hemorrhage.

material is available; otherwise the clamp should be left in place during transportation of the casualty to the advanced hospital (Fig. 170, *m*).

Provisions for Adequate Respiratory Airway

Loss of bony and muscular attachments frequently results in loss of *control of the tongue,* with danger to respiration. This is best controlled by exerting traction on the tongue by means of a long suture passed through the tip of the tongue, or by means of a safety pin passed through the tip of the tongue (Fig. 172, *a*). The suture should be long enough to allow the tongue to be drawn forward and attached

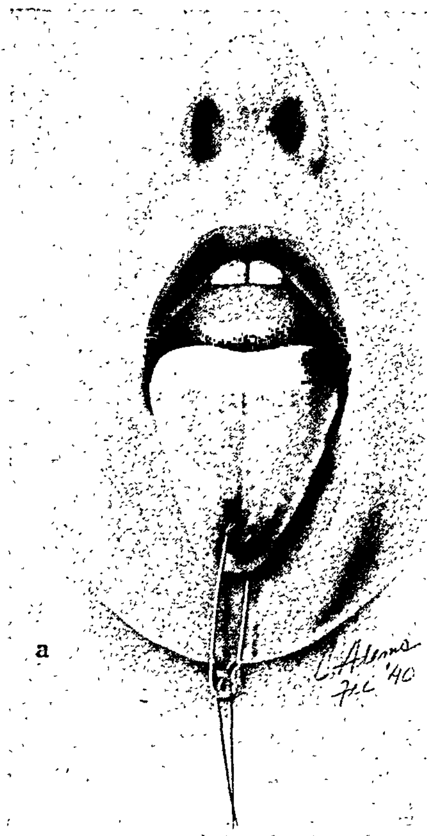






Fig. 172.—*a*, Safety pin transfixing tip of tongue for traction; *b*, extreme loss of bone and overlying tissue of anterior portion of mandible; *c*, supporting bandage and compress in position, with suture that has been passed through tip of tongue attached to the bandage to aid in maintenance of an adequate airway.

to the dressing. A piece of gauze or bandage can be tied to the suture for traction to clear and improve the air passage. These considerations

are particularly important if the patient is unconscious (Fig. 172, *b*, c).

In other cases, because of swelling of the soft tissues, a sufficient passage of air can be provided by insertion of a *metal or rubber airway* in the mouth and pharynx. In the more serious cases use of the *tracheal trocar* may be necessary. *Tracheotomy* should be considered

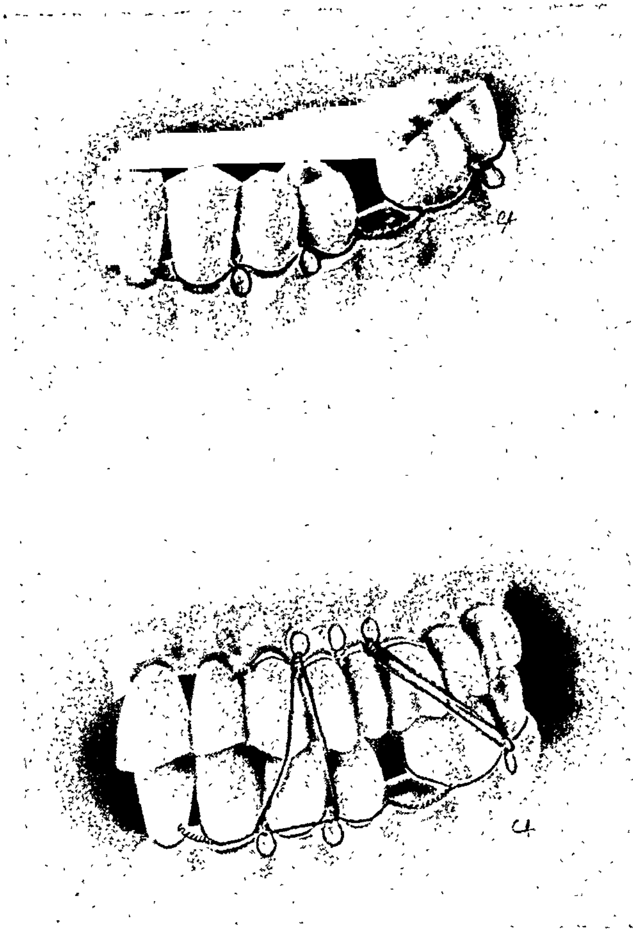


Fig. 173.—*Above,* intramaxillary multiple loop wiring across the line of fracture of the same jaw; *below,* in some instances elastic bands may be added for intermaxillary traction. See p. 271.

only as a last resort, since it is followed by high mortality when performed under the conditions contemplated here.

Temporary Approximate Reduction and Fixation of Fragments

Little more can be done at the first-aid station beyond application of the compress and four-tailed bandage indicated above, combined sometimes with elastic bands and safety pins. The dental sur-





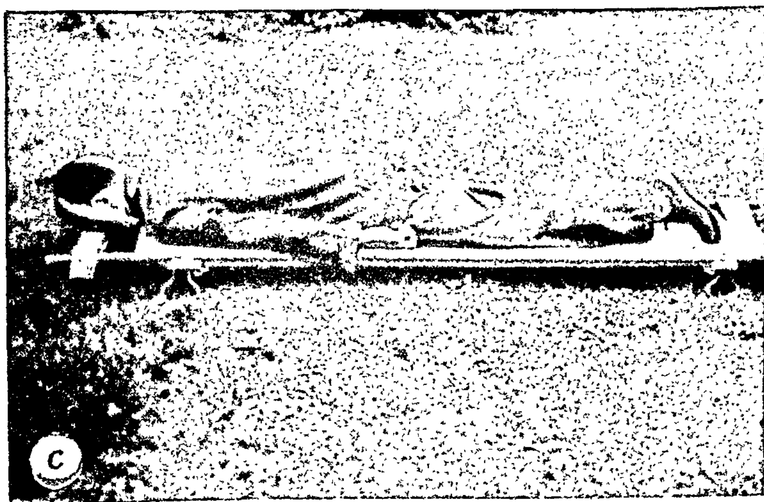


Fig. 174.

geon, if one is available, may have some equipment for application of temporary wires to the teeth. The teeth of the same jaw may be wired across the line of fracture in some cases to maintain fragments in position during evacuation of the patient to the rear, but *fixation of the lower to the upper teeth never should be done prior to unattended travel* (Fig. 173). *Fixation* is important at this stage, for stabilization of the fragments helps to reduce pain and shock. It also assists in the control of the tissues essential for maintenance of a clear air passage. *Stabilization* is necessary to avoid recurrent hemorrhage. Military conditions at the battalion aid station may necessitate deferring application of these measures by the dental officer until the casualty has reached medical installations farther to the rear.

Transportation from Combat Zone to Rear

Transportation or evacuation from the combat zone places a certain responsibility on Medical Department units. Casualties must be prepared for safe, unattended travel by ambulance or hospital train to hospitals. Lessons from past wars are convincing proof that the *ambulant or semi-ambulant patient with oral or pharyngeal wounds should sit up.* If he must be recumbent, as on the litter, he should be placed *face down* if there is any danger of obstruction of the air passages. These precautions reduce the mortality rate among patients with injuries of the jaw during evacuation (Fig. 174, *a, b,* c).

TREATMENT AT SURGICAL OR EVACUATION HOSPITAL

Early Care

More detailed examination of the wound is made here, and the patient is prepared for safe evacuation to the base. Hemorrhage is permanently controlled by ligation at important bleeding points, and general measures for the treatment of shock, such as transfusion and so on, are instituted. The maxillofacial teams attached to the surgical and evacuation hospitals, furnished from the auxiliary surgical units under control of Army Headquarters, are provided with all necessary equipment for early surgical care of injuries of the jaw and for fixation prior to evacuation to hospitals in the rear.

Injuries to Soft Tissue and Bone.—The surgical and dental members of the maxillofacial team examine the patients to determine the extent and nature of the injuries to soft tissue and bone. Wounds are

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Fig. 174.—Positions on a litter for patients with injuries of the jaw. *a,* Side, with head on side, supported by folded blanket; *b,* prone, with head on side, supported by folded blanket; c, prone, with face down, head supported on sling.

cleansed of all *foreign bodies,* such as pieces of missiles, stones, dirt, clothing, and so on, and are thoroughly cleaned with soap and water. All completely detached *splinters of bone* should be removed, as well as loose *teeth* and portions of teeth that have been carried into the soft tissues. These are elements that invite infection. However, any *loose fragments* of bone still attached to the soft tissues must be preserved, as they may provide a valuable nucleus for growth of new bone across a gap. Radical removal of such loose bone produces a defect which cannot be bridged by spontaneous regeneration and leads to prolonged treatment and bone grafting for restoration of continuity. It is better to leave a fragment of bone of doubtful vitality and remove it later if sequestration occurs. All loose teeth and roots involved in the line of fracture should be removed at this time, since they are potential sources of infection, delay healing, and thus prolong treatment. If a tooth of doubtful survival is the only one in a bone fragment of the mandible, it may be left temporarily to aid in keeping the fragment in position (Fig. 187, A, B).

Intramaxillary Wiring and Intermaxillary Elastic Traction and Fixation

The next consideration is reduction and temporary fixation of the fragments of bone in approximately normal or original position. This can be accomplished by attaching wire ligatures or arch wires to the teeth if a sufficient number of teeth are present in the upper and lower jaws (Figs. 175, 176). It may be safe to attach the lower to the upper teeth, using traction with *elastic bands* for fixation, if the fracture is comparatively simple and there is no embarrassment to the airway and little reaction in the soft tissues. *Do not wire the jaws together under any circumstance.* This avoids the danger of complications from vomiting and respiratory difficulty during evacuation to the general hospital. It must be remembered that wiring the teeth to an *arch wire* is a most satisfactory method of maintaining the fragments to avoid collapse of the segments. The nature of the wound may make it impossible to use any other means of intra-oral fixation. Further support of the parts can be secured by the use of bandages. The loss of bone and teeth is so great in some instances that only isolated teeth and bone remain. *Multiple loop wiring* for elastic traction will afford suitable fixation at this stage in such cases (Fig. 177).

Intramaxillary Multiple Loop Wiring.—This method of wiring for reduction and fixation of fractures was developed for two reasons: to secure the maximal anchorage for traction and retention and to apply the required treatment as rapidly as possible. Either Angle's standard







Fig. 175.—*a,* Gunshot wound, close range with extreme comminution of bone; intramaxillary wiring in place; *b,* third molar removed, sequestra separated; wiring still in place; c, fracture in region of first and second molars consolidated; sequestra removed; bone graft indicated for loss of substance; wiring removed.

brass ligature wire (0.020 inch or 0.508 mm.) or stainless steel wire (0.016 inch or 0.4064 mm.) may be used.

For a stable and satisfactory fixation, we shall consider the application of a single wire with multiple loops to four teeth, from the first molar to the canine. This will require a wire about 9 or 10 inches (about 23 or 25 cm.) in length to engage the four teeth, form three loops, and have the necessary length for twisting the ends together. If more teeth are to be included, a longer wire will be necessary (Fig. 177).

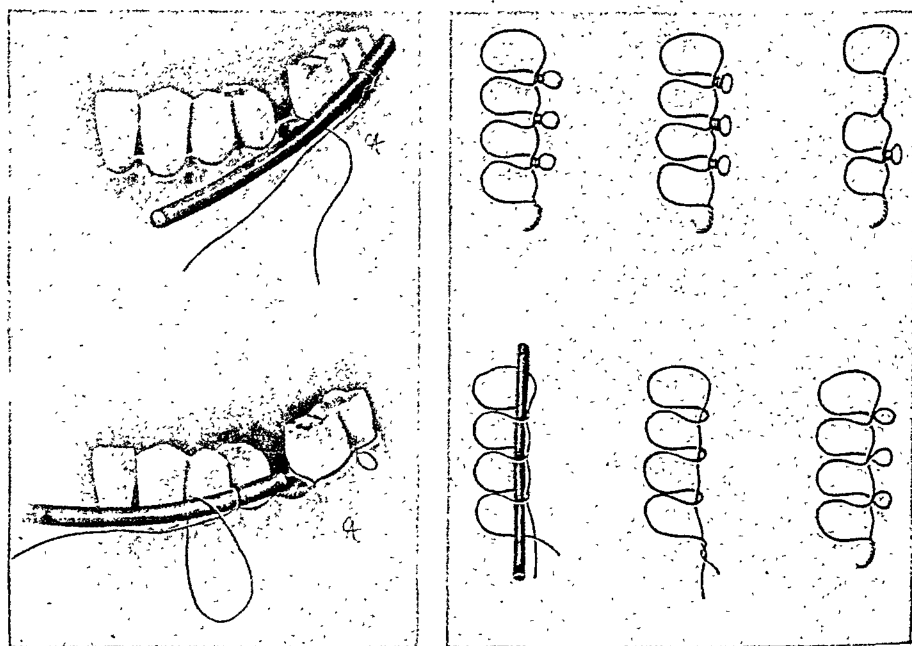


Fig. 176.—*Left,* application of intramaxillary wiring, using 8-gauge lead wire as a guide in forming the loops; *right,* relation of the wire and loops to the teeth (teeth removed).

Technic and Application.—The wire is first threaded through the interproximal space between the first and second molars, from the lingual aspect. The wire is pulled through buccally and forward, along the buccal surface of the teeth as far forward as the lateral incisor, allowing sufficient length for the final twisting of the ends at the mesiofacial angle of the canine. The long lingual end is threaded through the interproximal space mesial to the first molar, passing gingivally to the wire lying along the buccal surface of the teeth. The long end is bent back on itself and is threaded through the same interproximal space, forming a loop encircling the short buccal strand. At this point the end of the lead wire, gauge 8, and about 2 inches (about

5 cm.) long, is inserted in the loop and held parallel with the buccal wire and in contact with the buccal aspect of the teeth (Fig. 177, *a*). The lingual wire is now pulled tightly, giving the loop its proper form, size, and correct relation to the buccal wire and the teeth. The lingual wire is then threaded through the next interproximal space (between

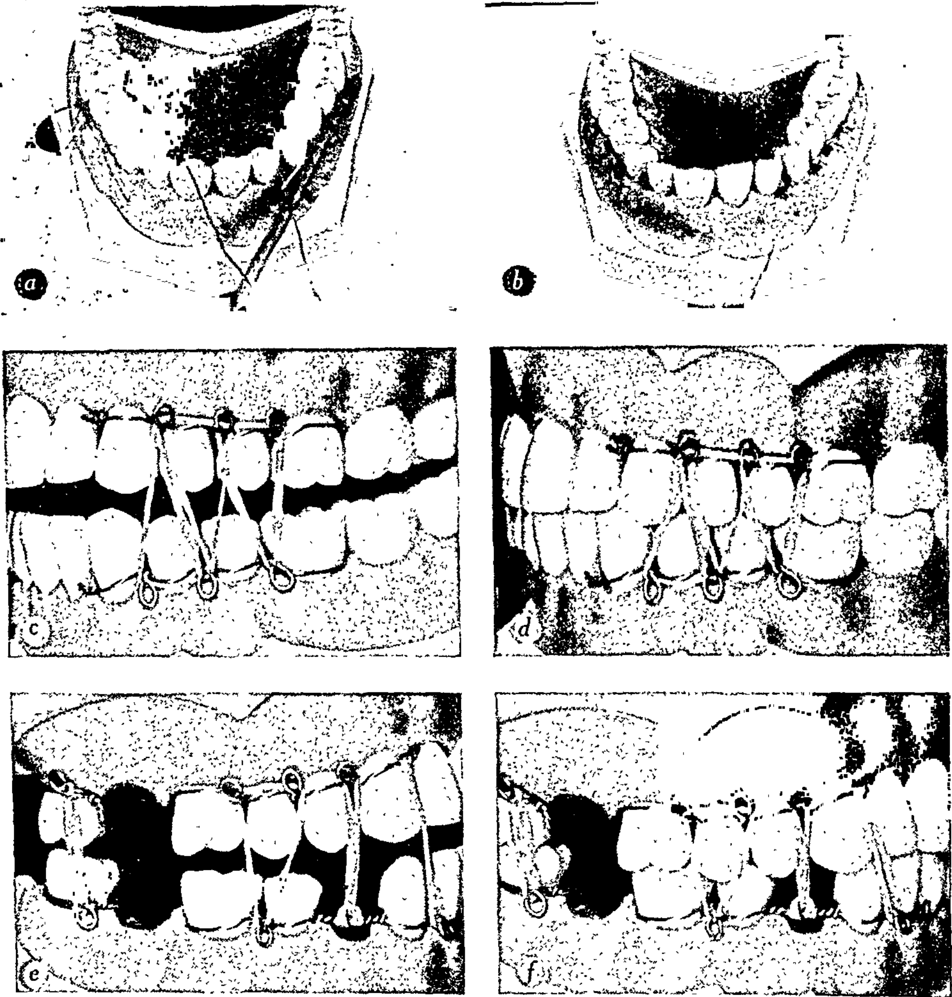


Fig. 177.—*a* and *b*, Steps in application of multiple loop wiring to models; *c* and *d*, multiple loop wiring on models, illustrating application of elastic bands forming a triangle, with base in one arch and apex in the other; *e* and *f*, application of the loops to single teeth and the method of twisting wire to bridge edentulous portions of the jaws.

the premolars), passing above the buccal wire and the lead wire; the end again is returned through the same interproximal space, forming the second loop (encircling the lead wire and buccal strand). In the same manner the next loop is made between the first premolar and the canine and the lingual end drawn tightly so that the lead wire is

held rigidly against the buccal surfaces of the teeth. The lingual wire is now threaded through the interproximal space between the canine and lateral incisor and again drawn tightly. Pull is exerted forward (mesially) on the buccal wire, with the same tension as on the other end. This will draw the loops all up into their proper position and give them the desired uniform size. The lead wire is now removed by rotating slightly and moving it forward. This is easily done by grasping the anterior end with pliers or the fingers.

The ends are now grasped with the pliers and twisted a few times so as to stabilize the wire and to bring the twisted portion to rest on the mesiofacial angle of the canine. The posterior loop is grasped with smooth-beak pliers (No. 122) and twisted three-fourths of a turn, which will place the loop in a horizontal position, bringing the buccal wire slightly into the embrasure. The other loops are treated in the same manner. This adapts the wire well around each tooth. Starting again with the twisted ends, they are given the final adjustment; twisting is continued until the wire fits the mesiofacial angle snugly. The excess twisted ends are cut off and neatly adapted against the mesial aspect of the tooth as well as into the embrasure. On occasion these twisted ends can be carefully adjusted and used as an additional hook. The next adjustment of the loops is accomplished by giving each one an additional half turn, which gives the wire the final adjustment around each tooth, carries the buccal wire closer into the embrasure, and secures the loops in their proper position. The final adjustment of the loops is to bend them gingivally so that they are in light contact with the gingiva and can be used as hooks for rubber traction (Fig. 177). Then, by use of small elastic bands, both intramaxillary and intermaxillary traction and fixation can be obtained as desired. The requirements of stable anchorage with a broad base involving a number of teeth have been fulfilled. Likewise application of the wire can be quickly accomplished and manipulation of the parts reduced to a minimum.

In Presence of Edentulous Portions.—In case these are encountered, the formation of loops can be interrupted and the wire twisted to bridge the spaces. The twisted wire strand that bridges the space assists in stabilization of the teeth in that arch and provides point of anchorage for intermaxillary elastic bands (Fig. 177, *e*, *f*; Fig. 188).

Extensive Loss of Maxillary Bone.—Wounds of the maxilla occasionally present such extensive loss of bone that the maxillary fragments cannot be maintained by attachments to the teeth. Stainless steel wire, provided in the maxillofacial kit, can be attached to the

teeth in the displaced fragments and carried with the pedicle needle through the cheek to attach to a head bandage. This will maintain the segments in approximate position, will assist in maintaining a clear respiratory airway, and will provide fixation until the casualty reaches the general hospital.

Forward Traction of Maxilla.—Fractures of the superior maxilla frequently cause displacement of the loose structures downward and backward definitely to interfere with respiration. The anterior part of the jaw may drop backward and cause serious interference with respiration in cases of bilateral, comminuted fracture of the posterior part of the mandible.

TONGUE-DEPRESSOR METHOD.—The front of the jaw can be held forward, in a case of this kind, by a simple emergency splint for extra-oral traction. Four wooden tongue depressors, adhesive plaster, a

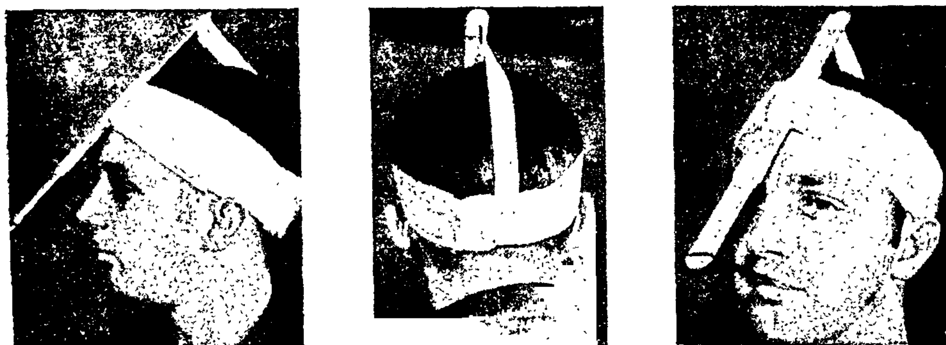


Fig. 178.—Extra-oral traction appliance using circular bandage, tongue blades, and adhesive tape for stability. *Left*, profile; *middle*, rear view; *right*, front view.

bandage 2 inches (5 cm.) wide, and the ligature wire that is supplied with the maxillofacial kit are employed. Two of the tongue blades are placed end to end, and the two other tongue blades, overlapping the first two in the middle, are wrapped with adhesive tape. This more or less flexible piece is placed vertically, with the lower end at the level of the chin, and is fixed to the forehead with a bandage. The upper end is held back with a broad piece of adhesive tape passing over the top of the head to the bandage at the occipital protuberance. A wire passed around the teeth or fragment of bone and attached to the splint with elastic bands can be used to control depressed fractures or segments of the superior maxilla. A wire passed around the lower front teeth, or around the chin segment of the mandible, and attached to the lower end of the tongue-blade splint with a suitable elastic band will provide sufficient traction effectively to maintain the anterior segment of the mandible (Fig. 178).

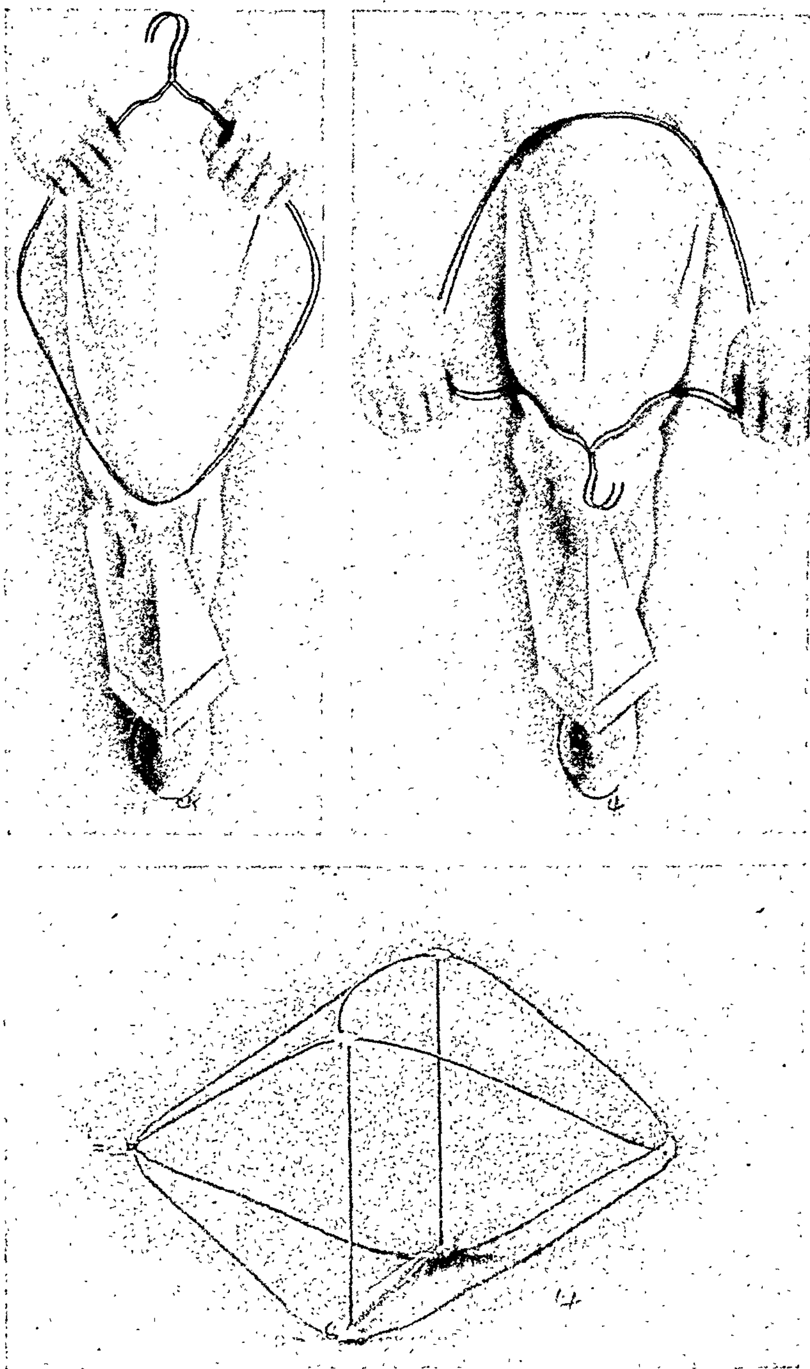


Fig. 179.—*Upper left and right,* a method of bending two coat-hangers to form the upper and lower halves of the wire frame; *lower,* upper and lower half stabilized by wire, secured with adhesive tape.

COAT-HANGER METHOD.—A more stable emergency apparatus for forward traction of the maxilla or mandible is made from two ordinary wire coat-hangers (Figs. 179, 180). Fig. 179, *upper left,* shows

the lower, straight portion of the coat-hangers being bowed to the proper shape by bending them over the knee. Fig. 179, *upper right,* shows outward angulation being produced by bending around the thigh. Fig. 179, *lower,* shows the two coat-hangers assembled, the points of contact being secured by thin strips of adhesive tape. A third piece of coat-hanger wire is used for reinforcement. It passes from the lower angle on one side to the upper angle on the same side, an average distance of 8 inches (20 cm.), then across the frontal region of the

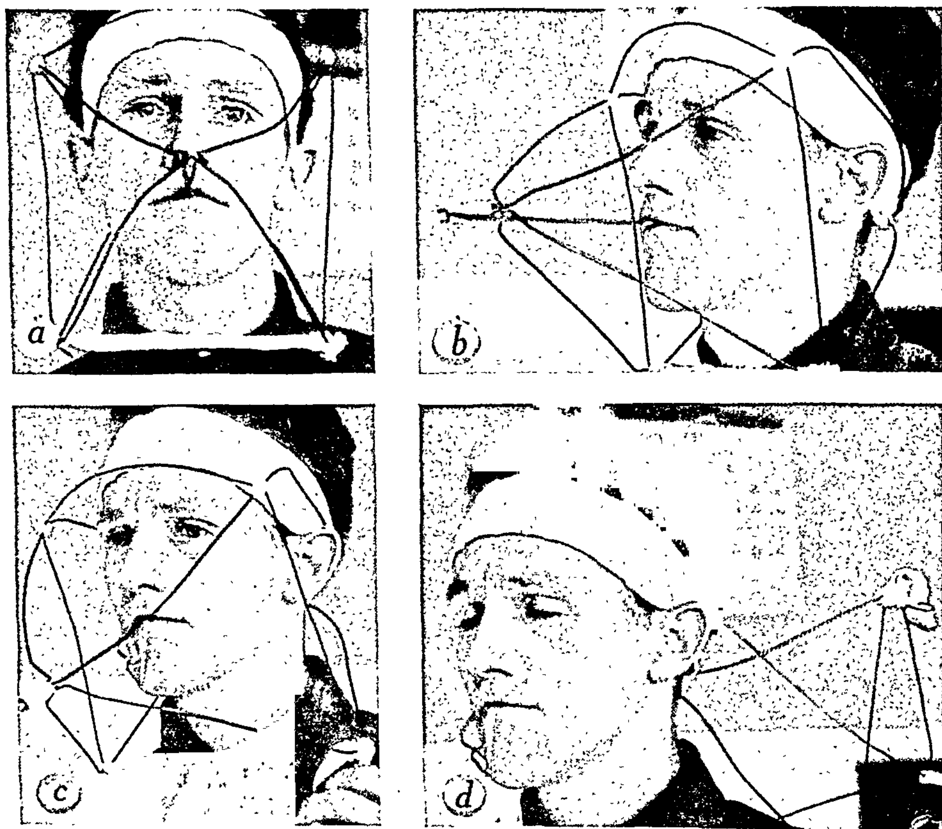


Fig. 180.—*a* and *b,* Wire frame in position, using a circular bandage with occipital anchorage for anterior elastic traction; *c,* elastic bands and connecting bandage unhooked for removal of frame; *d,* frame turned over the head to rest behind it.

upper angle on the opposite side, a distance of 9 inches (nearly 23 cm.), and finally down 8 inches to the other lower angle. The two lower angles are not connected with wire, but with a removable bandage connected to the wire angles with hooks. This should keep the two lower angles 7 inches (almost 18 cm.) apart. The apparatus is applied to the head with the original bend in the two coat-hangers resting against the occiput and secured there to a gauze bandage 2 inches (5 cm.) wide, passing horizontally around the frontal region and back

of the head; this bandage will have been applied previously. The hooked part of the coat-hangers extends well in front of the face, the hooks being cut off. Forward traction on either upper or lower jaw is then made by means of a heavy elastic band extending from multiple loop wiring on the teeth to the anterior point of the coat-hangers (Fig. 180, *b*). For feeding and so on, the apparatus can be released and turned back over the head by disconnecting the bandage which runs across the neck and between the two lower angles (Fig. 180, c and *d*).

Circumferential Wiring of Mandible

When teeth are insufficient for attachment of wires to control a displaced fragment, circumferential wiring of bone may be used to immobilize the parts until satisfactory consolidation takes place.

Technic and Application.—A small incision is made through the skin at the lower border of the fragment which the wire is to embrace, and the full-curved pedicle needle, which is supplied with the maxillofacial kit, is passed through this incision close to the lingual side of the bone, until the mucous membrane of the mouth is pierced. A piece of 24 gauge brass or stainless steel wire is threaded through the eye of the needle in the mouth and one end drawn, by means of the needle, out through the incision in the skin (Fig. 181, *above* and *lower left*).

If, after embracing the bone, the two ends of the wire are to come into the mouth, the needle is next passed down from the vestibule of the mouth, on the outer side of the bone, through the incision in the skin, and then the end of the wire which protrudes through this incision is carried up into the mouth on the outer side of the bone by means of the needle. The wire then embraces the fragment of bone, with its two ends emerging in the mouth (Fig. 181, *lower right*). These ends then can be secured in the manner applicable in the particular case, such as to the upper teeth, or twisted together over a splint resting on the alveolar mucosa of the lower jaw (abbreviated outline of periphery of a denture).

If the ends of the wire are to emerge from the incision in the skin, the needle is passed, after the first step, up into the mouth on the outer side of the bone through the cutaneous incision, and the end of the wire that is in the mouth is then drawn down on the outer side of the bone to emerge externally.

Traction can be made and maintained on the fragment in the direction indicated by attaching elastic bands to the ends of the wires. These can be anchored to a head cap or some other point of anchorage (Fig. 198).

Management of Soft Tissues

Attention is given to the wound in the soft tissue after satisfactory reduction and fixation of the fracture. The officer in charge of the

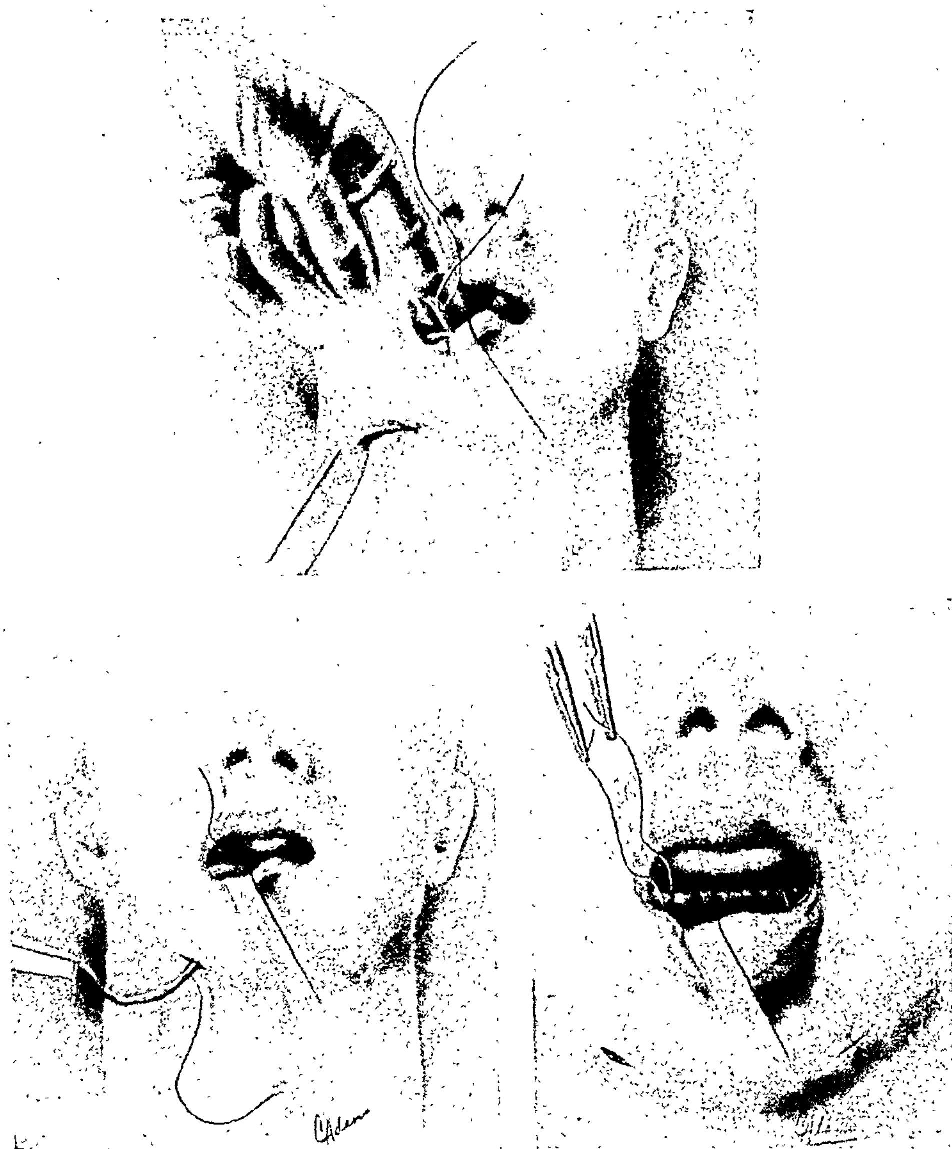


Fig. 181.—Circumferential wiring, using a pedicle needle to carry the wire around the bone. The steps are explained in the text.

patient may be tempted to close large, gaping wounds of the soft tissues by suture before giving attention to the fracture. This should not be done until at least temporary fixation of the bony fragments has been accomplished; collapse of the lateral segments or marked overlapping of fragments can be avoided; in addition, deformity and interference with function are not likely to occur.

Débridement, as understood concerning wounds of other parts of the body, is not carried out so extensively in relation to wounds of the

face, since vascularity of the face favors resistance to infection to a greater extent. Shreds of obviously devitalized tissue are cut away, but displaced flaps of tissue may be sutured back in approximate position. Great care should be taken to avoid injuring branches of the seventh nerve and the salivary duct. Edges of skin and mucous membrane in large wounds communicating with the mouth should be sutured together so as not to leave raw surfaces and bone exposed. Such exposure invites infection and formation of much scar tissue. Wounds of the soft tissue communicating with the mouth, or involving the mandible, that become infected should have dependent drainage provided. Wounds associated with the superior maxilla with adequate soft tissue remaining may be completely closed, and if drainage is indicated an intra-oral point may be established. The great value of *sulfanilamide* and its allied group of drugs, *sulfapyridine, sulfathiazole,* and *sulfadiazine,* has manifested itself in the treatment of war wounds in Europe. The local application of, or treatment systemically using, these medicaments, and other similar derivatives that may prove to be efficacious, offers an opportunity to carry many cases to completion without the usual complications.

Summary of Treatment at Advanced Hospital

1. Permanently control hemorrhage by ligation.
2. Cleanse the wound and remove all readily discovered foreign bodies, completely detached fragments of bone and teeth, and loose teeth and roots connected with lines of fracture. *Do not remove fragments of bone which have any attachment to soft tissue.*
3. Fix fragments of bone in approximately normal position by use of wires and elastic bands on the teeth available. Additional support may be given to the fragments by the use of compresses and bandages; likewise extra-oral and intra-oral traction appliances may be used.
4. Cut away devitalized soft tissue and restore torn flaps of tissue to approximately normal position. Suture edges of skin and mucous membrane to cover raw surfaces and exposed bone. Avoid suturing skin edges together so that overlapping of bone fragments or collapse of lateral segments will be increased.
5. Provide dependent drainage to wounds communicating with the mouth.
6. Administer sulfanilamide internally and apply sulfanilamide or sulfathiazole powder locally to the surface of the wound.

The time required for the wounded person to reach the general hospital, which may be situated 100 miles or more to the rear of the front line, varies considerably. The desirability of rapid evacuation to the place where definitive treatment can be given is obvious. The measures outlined above, if carried out properly, will insure that a large percentage of patients with maxillofacial injury will arrive at the base in good condition for definitive treatment.

DEFINITIVE TREATMENT (GENERAL HOSPITAL)

Every possible facility in the way of equipment and special personnel for proper care of the patients under consideration is provided for in the general hospitals. The definitive treatment can be grouped under the following headings:

1. Complete record of history to date.
2. General medical and physical survey to include all injuries and conditions of disease that may be present, especially acute respiratory and other infections.
3. Laboratory procedures, such as examination of blood and urine, bacteriologic cultures, and other measures.
4. Special maxillofacial survey, which is within the scope of this particular manual. This examination is to be conducted jointly by the surgeon and the dental surgeon and consists of:
   (*a*) Complete clinical examination of the region involved in the injury.
   (*b*) Roentgenologic examination of the bones of the face and jaw, intra-oral, extra-oral, stereoscopic, roentgenoscopic, and so forth, as indicated.
   (*c*) Record of findings.
5. The foregoing survey will reveal:
   (*a*) Structures involved in the injury to soft tissue: skin and subcutaneous tissues, facial nerve, salivary glands and ducts, floor of mouth, tongue, soft palate, neck, and other tissues.
   (*b*) Inflammatory conditions of the soft tissues: cellulitis, abscess, hematoma, and so forth.
   (*c*) Presence of foreign bodies.
   (*d*) Injuries to the teeth.
   (*e*) Location and extent of fractures of the bones of the jaw and neighboring bones, orbits, paranasal sinuses, nasal fossae, and so forth.
   (*f*) Infection of bone.

Inflammatory Conditions of Soft Tissues

Practically always infection is present from dirt and other foreign material carried into the wound from the outside and because of the easy access of pyogenic bacteria to the badly lacerated and devitalized soft tissues. Exposure of the fracture to the oral fluids, which are infested with bacteria, is another source of infection of bone and soft tissue. Diseased teeth in the region of the injury may be causative factors. Fragments of teeth and bone may be carried into the soft tissues and may set up infection. Infection is to be expected in the interval between receipt of the wound and arrival of the patient at the general hospital, especially if it has not been possible to eliminate many of the causes at the advanced stations. Lack of early fixation of bone predisposes to infection of the wound. This is manifested by swelling and edema about the edges of the wound, together with rise in the temperature of the body and other general symptoms. Fluctuation may be detected in the swelling. The abscess may be localized or spreading cellulitis may be present. Gas bacillus infection (Clostridium welchii) is extremely rare in wounds about the face and jaws.

Foreign Bodies and Detached Fragments of Hard Tissue

These may be carried into the bone and soft tissues by the projectile. Among them are: parts of the missile itself, pieces of clothing, stones, glass, gravel, and other materials. Foreign bodies often complicate the injury by prolonging infection, leading to secondary hemorrhage, and also obstructing function of movable parts. In case of a bullet wound, the absence of a wound of exit is usually good evidence that the bullet is still present in the tissues. It is possible to have a single wound about the jaws without a bullet remaining, since it may have entered or made its exit through the open mouth. These foreign bodies may be discovered by clinical examination, but may be revealed only roentgenologically (p. 47).

Any overlooked, completely detached fragments of bone, any pieces of teeth, injured teeth, or foreign bodies, revealed by clinical or roentgenologic examination, should be removed as soon as possible.

Injuries to Teeth

Crowns of teeth may be entirely or partially carried away. Fragments of teeth may be embedded in the soft tissues, setting up secondary foci of infection, and may be discovered by clinical and roentgenologic examination (Fig. 175). Teeth may still be attached to the

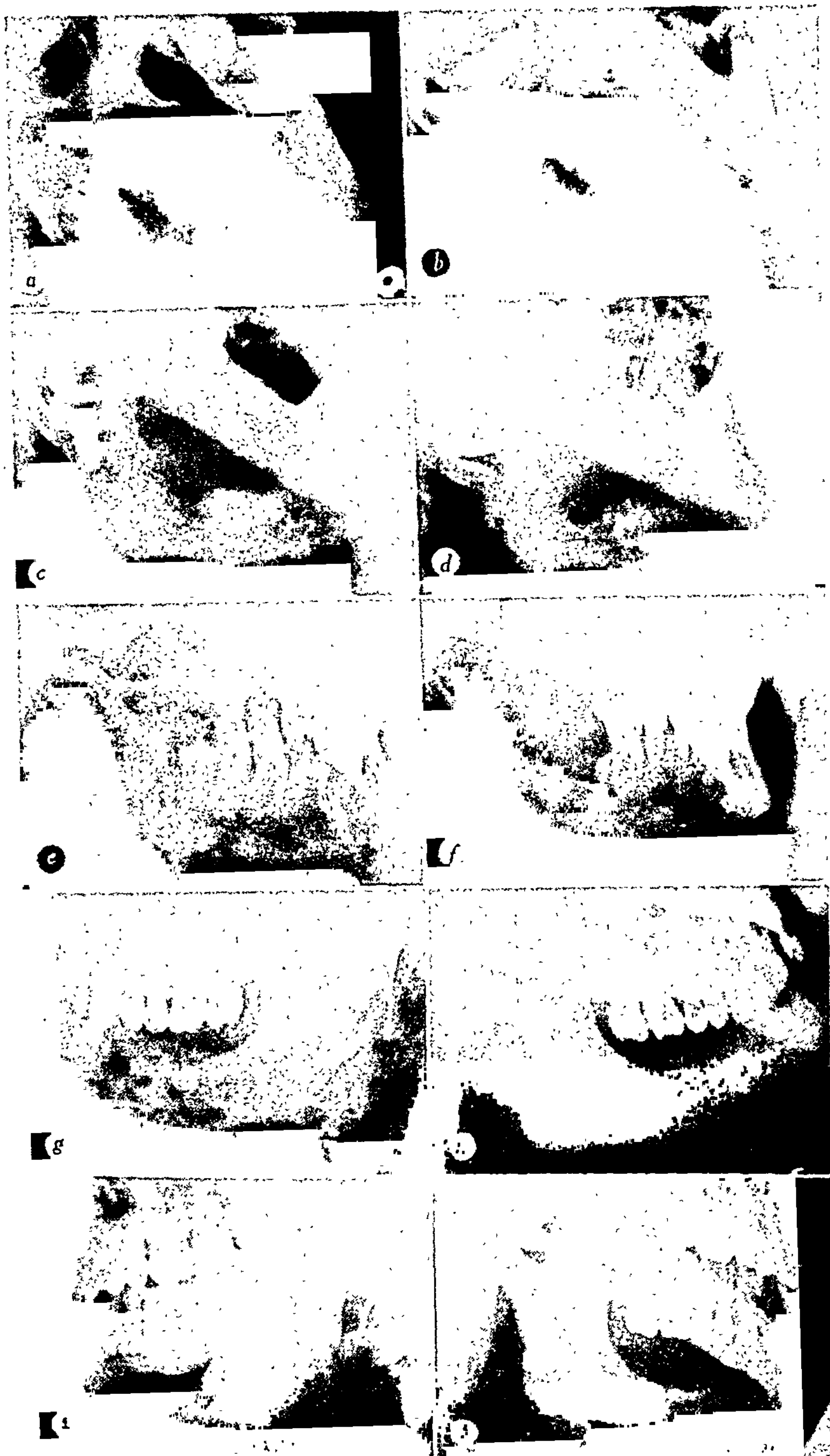


Fig. 182.—*a* through *d*, Roentgenographic evidence of osteomyelitis of mandible; *b*, sequestrum formed; *c*, sequestrum removed; *d*, consolidation of bone; *e*, osteomyelitis of mandible with pathologic fracture and sequestrum separated; *f*, sequestrum and two teeth removed; consolidation progressing; *g* and *h*, osteomyelitis, diffuse type, right and left sides of the mandible; *i* and *j*, consolidation after conservative treatment, with adequate drainage.

jaw but may be partially exposed in the line of fracture, thus giving rise to later complications, such as cellulitis, abscess, osteomyelitis, delayed union and so on.

Infection of Bone

The same factors that contribute to infection of soft tissue cause infection of injured bone. Comminution of the bone, especially with shattering of teeth and denudation of overlying soft tissues, almost always results in a certain degree of osteitis and, later, osteomyelitis. This is favored by the presence of devitalized roots of teeth. Severe pain in the bone itself is indicative of osteitis. The tissue about the fracture is red, tender, and swollen, and pus may be discharged spontaneously around the teeth. The temperature is usually elevated. Prolonged drainage, through the oral wound, the external wound, or an opening in the skin, usually indicates that there is a definite osteomyelitic focus in the fragments of bone. Spreading of the osteomyelitis is characterized by suppuration around, and progressive loosening of, previously healthy teeth not immediately in the line of fracture. In the early stages of osteomyelitis, roentgenologic examination may reveal very little. Later, blurring of the shadow of the fine, cancellated structure of the bone will be seen (Fig. 182, *a*). Devitalization of a segment of bone results, as the infection progresses, in formation of a sequestrum. A line of demarcation forms between the sequestrum and the adjacent or surrounding live bone, and separation of the sequestrum eventually takes place. As sequestration occurs, a shell of new bone may be formed at the same time to take its place. These late changes may be followed more or less closely by roentgenologic examination (Fig. 182). Regeneration of the bone after necrosis in the lower jaw is of much more common occurrence than in the upper jaw.

Treatment.—Conservatism should be the rule. Nothing radical should be done to the bone in the earlier stages of osteomyelitis. Curettage or excision of part of the bone at this time may aid spread of the infection and interfere with regeneration; it may do more harm than good. *Provision of drainage* by incisions to the periosteum is all the operative interference indicated in the earlier stages.

Later, as sequestra form and loosen, they should be removed. Sometimes a sequestrum will be locked in a surrounding shell of new bone, in which case it is permissible to take away enough of the newly formed shell to free, and permit the removal of, the sequestrum.

CHAPTER XII

FRACTURES OF THE JAWS

THE position of fragments in the jaw should be carefully studied and, if the fixation previously applied remains satisfactory, it need not be disturbed. If, on the other hand, the temporary fixation by wire and elastic bands is inadequate to retain the fragments in correct position,



Fig. 183.—Clear acrylic resin splint stabilizing fracture of the mandible in the region of mental foramen.

impressions of the mouth are taken for the purpose of making and applying more permanent splints (Fig. 183) as soon as the acute inflammatory reaction has subsided (p. 322).

Types of Definitive Fixation

The type of definitive fixation employed depends on several conditions, such as location of the fracture, amount of bone lost, presence or absence of teeth in fragments, amount of displacement, and so on. A splint on the mandibular teeth alone might give adequate fixation for a fracture of the body of the mandible with several good teeth on each side of the fracture; it has the advantage, also, of permitting mastication of more or less solid food (Fig. 183). Some form of fixation

to the upper teeth is necessary for mandibular fracture behind the line of teeth (Fig. 187, C). A pin extension from the splint may be needed for control of an edentulous posterior fragment (Fig. 187, D). A sectional splint with provision for expansion is indicated for treatment of collapse of the two sides of the mandible attributable to loss of the portions including the symphysis. These various types of splints are described in detail on pages 322 to 338.

Extra-oral methods of fixation, combined with circumferential wiring of the fragments of bone, may be necessary when large mandibular fragments are edentulous, thus precluding control by means of the teeth. Some of these extra-oral methods already have been described (pp. 276 to 280). In other cases the circumferential wires can be attached to hooks and bars embedded in a plaster-of-paris head cap (Figs. 195, 198).

FRACTURES OF MANDIBLE

The usual injury to the mandible in war is characterized by comminution or external destruction, as previously described. On the other

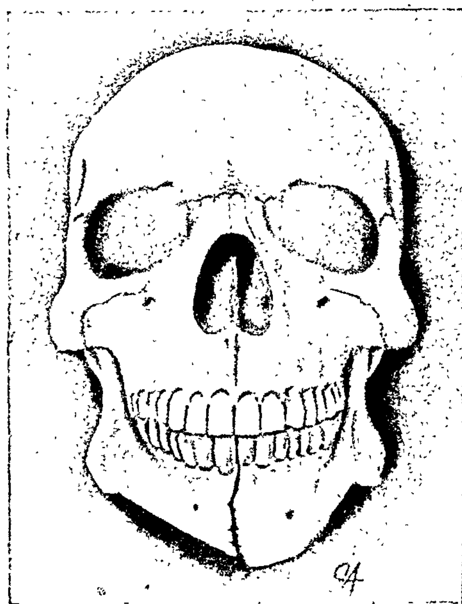


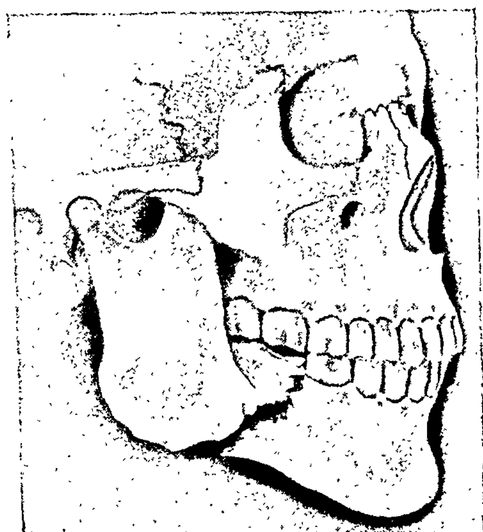
Fig. 184.—Fracture of the mandible in region of the symphysis, with collapse of lateral segments.

hand, only a contusion of the soft tissues frequently may be evident but it will be accompanied by a break in the bone, with little or no comminution, simulating the fracture commonly encountered in civil life.

Displacement

The degree of displacement in cases of fracture of the mandible depends on the direction and strength of the traumatizing force, the amount of comminution, the presence or absence of opposing teeth and, above all, the action of the muscles attached to the separated





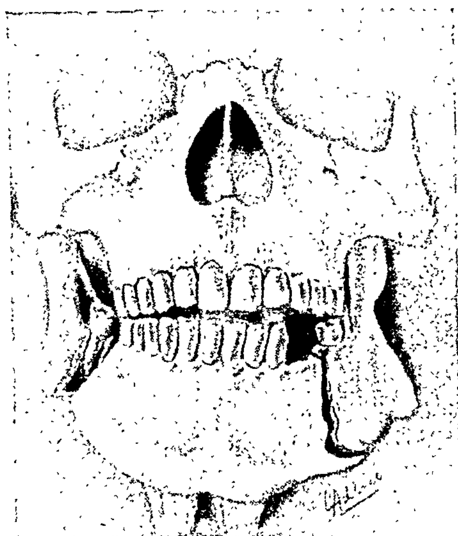
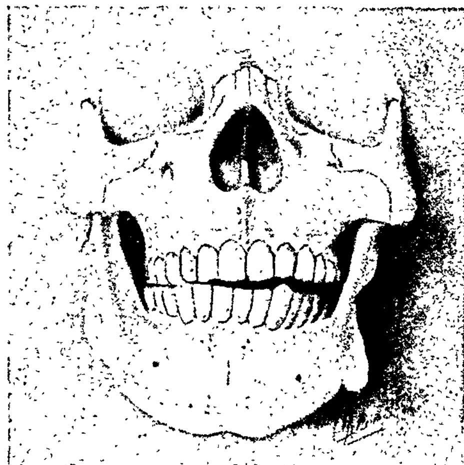


Fig. 185.—*Top,* fracture of mandible with teeth in the posterior fragment; *lower left,* unilateral fracture of mandible without teeth in posterior fragment; *lower right,* bilateral fracture of mandible, with typical displacement of fragments.

fragments. Fractures in different locations present definite characteristic displacements.

Fractures at Symphysis.—When there is considerable comminution or loss of substance of the symphysis, with loss of teeth, the two halves of the mandible tend to be drawn together by contraction of the mylohyoid muscles at the median line, so that there is marked narrowing of the lower dental arch (Fig. 184).

Unilateral Fracture of Mandible in Region of Mental Foramen.—The short fragment posterior to the fracture is elevated and held by contraction of the elevator muscles (temporal, masseter, and internal pterygoid), with the teeth in normal occlusion with those of the upper jaw when there is a good complement of teeth in both jaws. The large



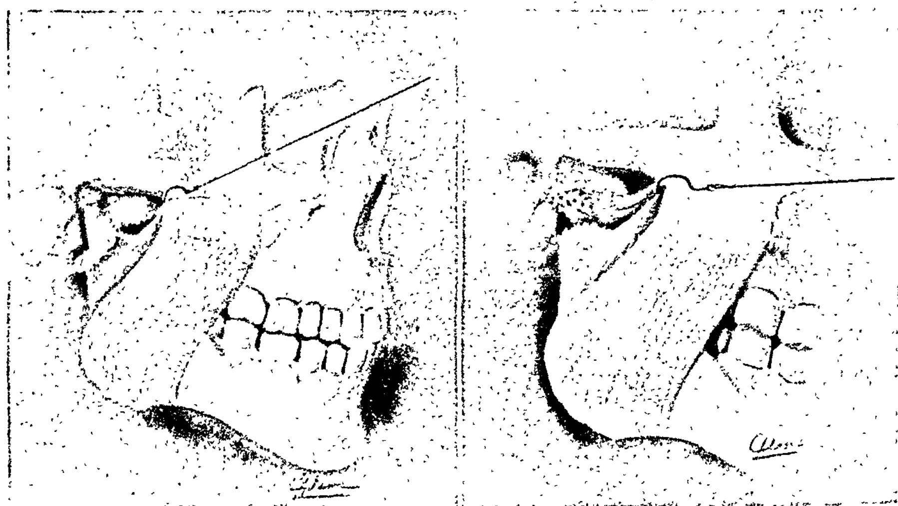


Fig. 186.—*Upper,* fracture of neck of condyloid process, with mandible displaced to that side; *lower left,* side view; *lower right,* condyle displaced anteriorly and medially.

fragment is depressed by the muscles running from its lower border to the hyoid bone (digastric, geniohyoid, and mylohyoid), so that the anterior teeth do not occlude with those of the upper jaw (Fig. 185).

Moreover, there may be some backward displacement and lateral deviation of the chin segment to the side of the fracture, with overlapping of the fragments in severe cases of comminution. The eleva-

tor muscles accentuate the upward displacement of the short fragment when there are no lower teeth opposing the posterior teeth of the upper jaw (Fig. 185, *lower left*). The short, posterior fragment also may be displaced outward or inward.

Bilateral Fracture of Body of Mandible.—The chin segment is drawn downward and backward by the hyoid group of muscles, and the posterior fragment is held up by the elevator muscles. This collapse of the middle fragment, especially in cases of comminution, may allow the tongue and soft tissues to fall back and interfere with respiration and swallowing (Fig. 185, *lower right*).

Fracture of Ramus.—Displacement may be slight, owing to investiture of the fragments by thick muscles, if there is little or no comminution. Shortening will occur, with noticeable deviation of the chin toward the fractured side, when comminution or loss of substance occurs.

Fracture of Neck of Condyloid Process.—This fracture is nearly always attributable to indirect force, such as a fall or blow on the opposite side of the chin. The condyle sometimes is pulled forward and inward, out of the glenoid fossa, by the external pterygoid muscle (Fig. 186, *lower right*). On the other hand, the condyle may remain in its socket, the lower end of the small fragment being tilted forward and outward (Fig. 186, *upper* and *lower left*). In any event, the distance from the angle of the mandible to the glenoid fossa on that side is shortened. The distance between the maxillary and mandibular teeth with the mouth open is less on the injured than on the normal side, and the whole mandible drifts toward the injured side. Bilateral fractures through the necks of both condyloid processes are sometimes seen. The whole lower jaw is displaced backward in these cases (Fig. 187, *m*, *n*).

Further Use of Intramaxillary Multiple Loop Wiring.—This method was described when treatment at the surgical or evacuation hospital was under consideration (pp. 272 to 276 and Figs. 175, 176, 177). Likewise, intramaxillary multiple loop wiring using elastic bands for traction and fixation is particularly useful in connection with definitive treatment, to be applied in the general hospital. Therefore, it must be mentioned here. Several methods are represented in Fig. 188.

External Pin Fixation for Edentulous Fragments of Mandible

The control of edentulous fragments, or satisfactory fixation for fractures of edentulous jaws, always has constituted a serious problem. In many instances, the methods presented on previous pages



Fig. 187.

have proved most gratifying. In the care of some patients of the type here considered, however, it will be found necessary to resort to a more stable, extra-oral method of direct, skeletal reduction and fixation of fragments. Such a method has been recognized by several oral surgeons and has been used most successfully by the British.

The method introduced by Roger Anderson for fractures of long bones has been adapted for use in some cases of fracture of the edentulous mandible. In the Roger Anderson kit a sufficient number of units are provided for several cases. Made of stainless steel, the appliance can be assembled and sterilized ready for attachment.

The simple apparatus consists of two or more locking units. Each of these units firmly holds two Kirschner pins, for engagement of the fragments, and an adjustable traction bar is attached to the locking units. The pins are 1.5 mm. in diameter and 2 or 2½ inches (5 or 6 cm.) in length. One end of each pin is threaded and sharpened as a drill point and the other end is prepared to engage a T-bar wrench. Bars of various lengths and some with angle extensions are supplied for use in cases in which there are multiple fractures and for those in which a fixation point in the ramus and in the symphysis is required. Simplicity, ease of application, wide variation of movement for adjustment, accuracy, and means for immediate reduction and rigid fixation of fragments in final position, are the characteristics of the army modification of the Roger Anderson pin appliance (Fig. 188½).

Use of the apparatus, however, demands the most careful application and skill on the part of the dental oral surgeon. Scrupulous attention to surgical care of the skin and soft tissues is necessary before fixation of the pins. After the operative field has been surgically prepared, a bistoury is used to cut the skin over the points where the pins are to engage the bone fragments. Moreover, complications, extensive necrosis, and osteomyelitis will result unless careful attention is given to the details of application.

Fig. 187.—*a*, Fracture of mandible through angle and third molar tooth; tooth fractured; mesial root in anterior fragment; distal root in posterior fragment; *b*, fracture consolidated; distal root was retained to control posterior fragment until consolidation took place; *c*, fracture of mandible; full-coverage splint with saddle portion to control posterior fragment; splint wired to upper teeth; *d*, clear acrylic splint with extension pin to control the posterior fragment is more effective and gives limited function; *e* through *h*, multiple fracture of mandible; *e*, dislocation of condyle upward to a position under the zygomatic arch; *f*, fracture of neck of condyloid process and coronoid process; *g*, posterior-anterior view, showing additional fracture in region of right canine and lateral incisor; *h*, posterior-anterior view; dislocation and fractures reduced, using intramaxillary multiple loop wiring with intermaxillary elastic bands for traction and fixation.



Fig. 187.—*i* and *j*, Multiple fracture of mandible (*continued*); *i*, right side; condyle in the glenoid fossa; occlusal relation of teeth restored; *j*, left side; consolidation taking place; occlusal relation of teeth restored; *k*, fracture of neck of condyloid process; *l*, fracture reduced and immobilized by placing teeth in anterior occlusion and cross-bite, thereby correcting the posterior border of the ramus; *m* and *n*, bilateral fracture of neck of condyloid process; condyles dis-

Experiences of dental oral surgeons here and abroad indicate that use of the bone bur in preparation of holes for insertion of the pins is contraindicated, for the heat generated by the rapidly moving bur

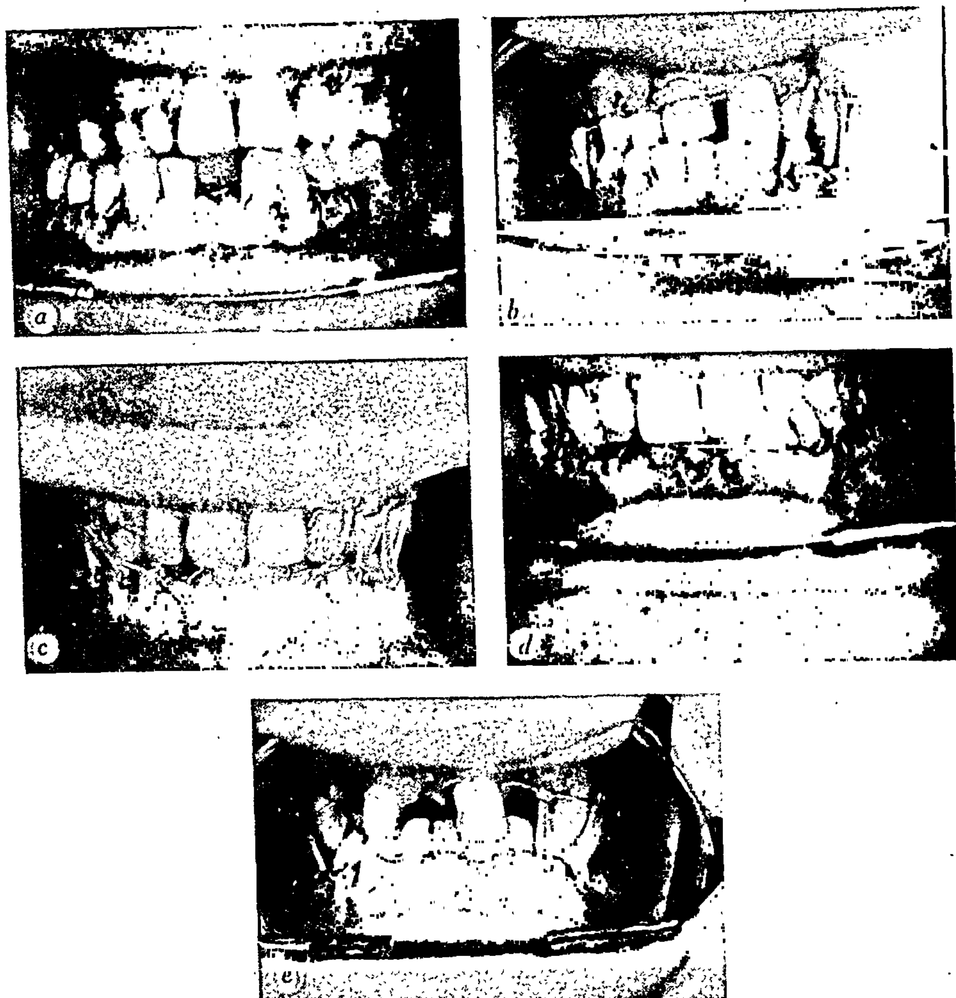


Fig. 188.—*a*, Intramaxillary multiple loop wiring applied prior to application of elastic bands; *b*, *c*, *d*, *e*, variations in the application of intramaxillary multiple loop wiring, using elastic bands for intermaxillary traction and fixation, as indicated.

will burn bone and kill bone cells. This will result in necrosis or destructive and complicating osteomyelitis. Insertion of the pins is accomplished by screwing them into the fragments close to the inferior border of the fragment of the mandible. Slowly the drill-pointed pin

placed anteriorly and medially; occlusion restored by intramaxillary multiple loop wiring, using intermaxillary elastic bands for traction and fixation; *o*, unilateral fracture of neck of condyloid process, condyle displaced anteriorly and medially; *p*, fracture through head of condyloid process, approximately two years previous to taking of this roentgenogram; picture discloses establishment of false joint, with hypertrophy of bone in the region; joint is capable of good function.

will thread itself into the fragment in such a manner that it can be firmly held by the locking unit. The pins may engage the fragment at divergent or convergent angles but must be so placed that they can be securely engaged by the locking unit.

When properly applied, the apparatus that has been described will immobilize the fragments, permit function of the mandible, and assure repair of the bone with a minimum of discomfort to the pa-

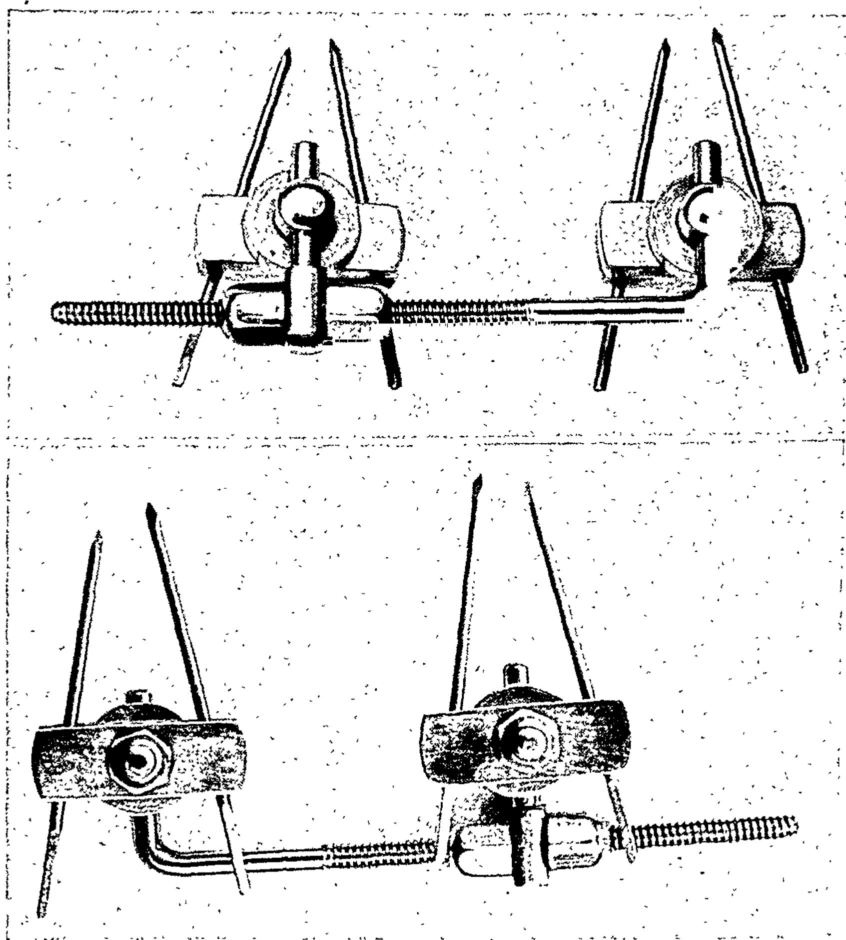


Fig. 188½.—Two views of appliance for external pin fixation.

tient. The pin appliance should not be used if patients have firm and healthy teeth in each fragment, for other methods of fixation presented in this text are then superior.

Trismus and Ankylosis

Nearly all fractures of the mandible, especially those involving the angle and the ramus, are followed by a period of limited opening of

the jaws. This limitation of movement may be attributable to lack of use and atrophy of the muscles of mastication, or to fibrous-scar contracture following healing of the wound of the soft tissues. On the other hand, ankylosis may be present, with partial or complete immobilization of the joint. This results from actual bony fusion in the region of the joint. The diagnosis of the particular type of immobilization is made by clinical examination and sometimes by roentgenologic methods.

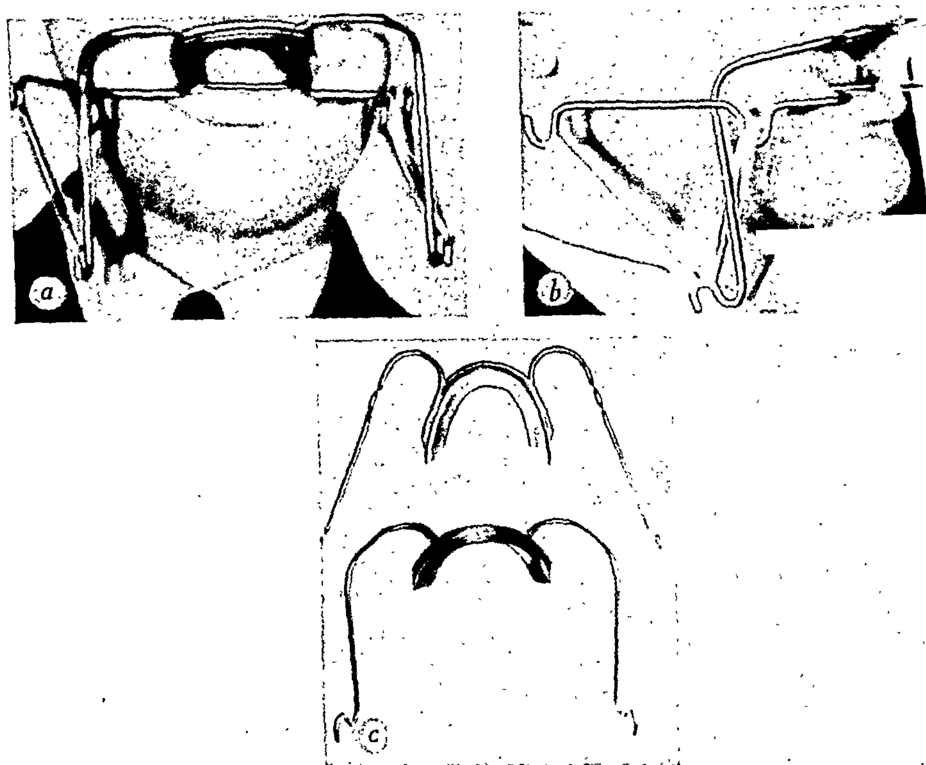


Fig. 189.—Trismus appliance. *a*, Front view of patient with appliance in use; *b*, side view; elastic bands give exercise to the involved muscles; *c*, the appliance.

Treatment of Trismus.—*Exercises* of the jaw may be of benefit when the trismus is caused by lack of use and atrophy of the muscles of mastication. The mere act of *chewing* may bring about gradual improvement. The use of *mechanical dilators* may be helpful if this is not sufficient. The simplest of these is the ordinary wooden clothespin, as suggested by Prinz. The ends of this are cut down to a sharp edge and inserted between the teeth. One of these devices can be given to the patient, who frequently will accomplish a great deal in a few days by its persistent use. Great benefit may be obtained in the more stubborn cases by regular application of a mild, interdental *elastic*

force to separate the upper and lower jaws. Fig. 189 shows an apparatus which is effective for this purpose.

APPARATUS FOR DILATING.—The two parts of the appliance are similar. Each is partly composed of a flat metal tray, which is passed between the occlusal surfaces of the maxillary and mandibular teeth. The tray can be inserted if there is an initial opening between the anterior teeth of ⅜ inch (1 cm.) or less. Heavy bars which pass out of the corners of the mouth and curve backward over the cheeks are soldered to the outer sides of each tray. The bar attached to the upper tray on each side turns down at a right angle opposite the premolar region and ends in a hook about 3 inches (about 7.5 cm.) lower down. The bar attached to the lower tray passes directly backward, horizontally, and is provided with a hook at a point opposite the downward turn of the upper wire. The dilating force is a heavy elastic band that is placed between these hooks on each side. This application of dilating force in the manner described is original with Darcissac. He, however, made individual apparatus from impressions in each case, casting metal caps to fit the teeth. The advantage of the present appliance is that it is ready for immediate use in cases in which the oral opening would not permit of taking of impressions. The elastic bands produce constant counteraction to the powerful elevator muscles of the mandible which, at the same time, are permitted to function. The upper and lower jaws are not fixed at any time. Lateral movements, as well as opening and closing, are possible. The trays can be filled with a little softened impression compound to receive the imprint of the teeth before insertion if additional stability is desirable. The compound can be renewed from time to time. The dilating force can be regulated by the size and tension of the elastic bands. The apparatus can be inserted by the patient. It should be worn for fifteen or twenty minutes three or four times a day. It usually produces a satisfactory result within a week or ten days.

Fixation by Scar.—Operative intervention may become necessary in the presence of fixation by scar in order to achieve the required opening of the mouth. Mere section or removal of the scar will not give a permanent result when an intra-oral scar involves the loss of the oral mucous membrane. Raw surfaces must be covered immediately by flaps or grafts of skin (Section I), to prevent re-formation of the scar tissue after intra-oral section or removal of scar tissue. When the fixation is attributable to external scarring, some form of plastic procedure on the soft tissues must usually follow excision of the scar.

Bony Ankylosis.—In the presence of this condition, the liberation

of the jaw requires removal of a considerable section of the upper part of the ramus of the mandible. This is generally followed by interposition of masseter or temporal muscle flaps to prevent regeneration of bone across the gap.

Technic of Operation for Bony Ankylosis.—In recent years we have found the operation proposed by Risdon satisfactory. It is especially useful when the coronoid process is involved in the ankylosis. An incision 1 to 1½ inches (2.5 to 3.8 cm.) long is made immediately beneath the lower border of the mandible, starting just behind the angle and running forward. The incision is carried to the lower border of the bone. The soft tissues, including the insertion of the masseter muscle, are stripped away from the outer surface of the ramus almost as high as the mandibular (sigmoid) notch. A surprising amount of exposure of the outer surface of the ramus can be obtained by retracting the overlying tissues upward. With a sharp chisel, the ramus is now divided transversely just below the sigmoid notch, freeing the mandible. The gap can be widened by further removal of bone above it, with a gouge or biting forceps. By exercising care it is generally possible to avoid injury to the underlying inferior dental nerve and vessels. Instead of the chisel, a Gigli saw, introduced around the ramus by means of the Blair, full-curved pedicle needle, can be used to cut through the bone with less trauma (Fig. 190, *a, b*). A section from the detached lower end of the masseter muscle is now inserted in the gap in the bone; generally this section can be fastened with a catgut suture to the internal pterygoid muscle, lying on the inner side of the ramus. This interposition of muscle helps materially in preventing reunion of the divided bone. The operation is attended with practically no danger of injury to the facial nerve. It also has the advantage of better preserving the length of the jaw on the affected side.

The use of a trismus appliance or exerciser, such as is described (p. 297), following these operative procedures is very helpful in maintaining or reestablishing functional movements of the mandible.

Malunion

Fractures of the jaws which have not been properly reduced and fixed may unite in the position assumed by the fragments following the injury. This is true particularly in cases in which there is loss of substance. The malunion may be fibrous or bony.

Treatment of Malunion in General.—Malunion of the mandible is more easily corrected than that of the maxilla. It may be possible to reduce the fragments to normal position by gradual *elastic traction* if the patient is seen before consolidation has become complete.

Fibrous bands can be cut and the fragments immediately reduced, and fixed in normal position by wires or splints. *Osteotomy* through the original line of fracture, followed by reduction and fixation in correct position, is indicated if firm bony union in bad position has occurred. The simplest conditions to treat are those in which there has been no loss of bone and the ends of the fragments come into apposition after reduction. A second operation, to supply new bone

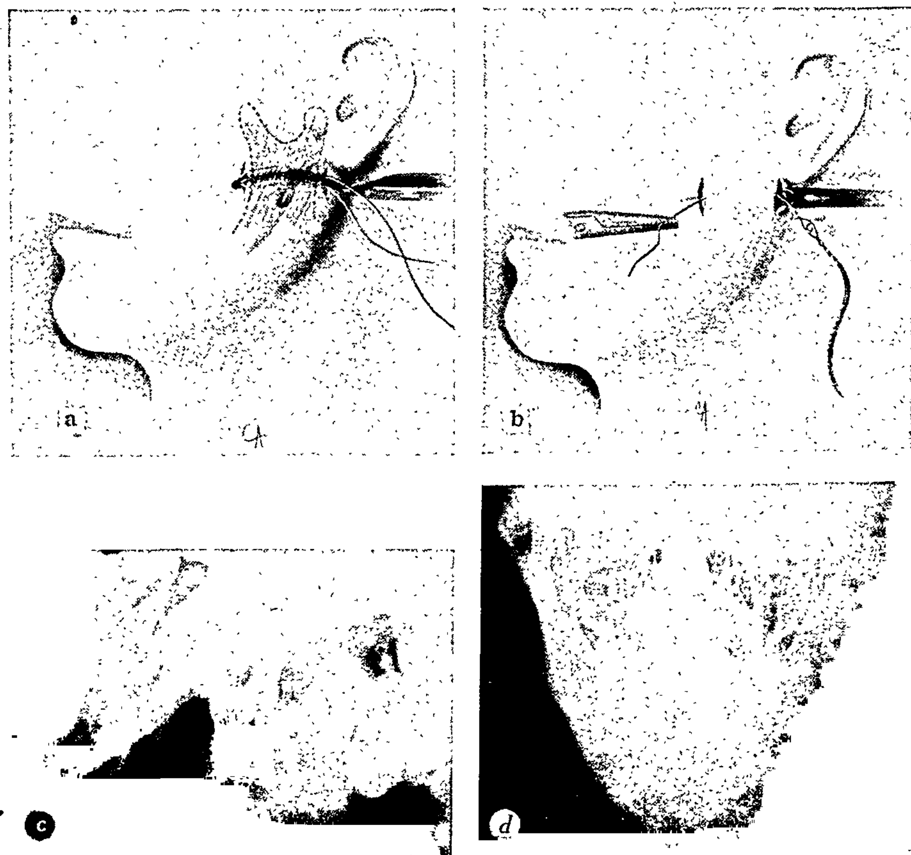


Fig. 190.—*a* and *b*, Osteotomy; wire, passed around the ramus with a pedicle needle, used to draw the Gigli saw into position; *c*, ankylosis of mandible, right side; *d*, osteotomy at site of ankylosis.

after osteotomy and reduction, may be necessary if the loss is considerable.

Osteotomy.—This is performed at the point of malunion. A narrow chisel can be used, but the operation can be accomplished with less trauma if a Gigli saw is used.

Make a small incision through the skin, not longer than ½ inch (about 1.3 cm.), along the lower border of the mandible at the site of malunion. Pass through this incision the full-curved pedicle needle

employed in circumferential wiring. Keep it close to the inner surface of the bone and pass it through the mucous membrane of the mouth. Carry a Gigli saw, by means of a wire through the eye of the needle, against the inner surface of the bone, leaving one end in the mouth and the other emerging through the incision in the skin. Section the mandible with the saw, from within outward, through the old line of fracture (Fig. 191).

Suture the cutaneous incision. This heals usually by first intention, leaving practically no visible scar. Reduce the bone fragments and treat as a recent fracture.

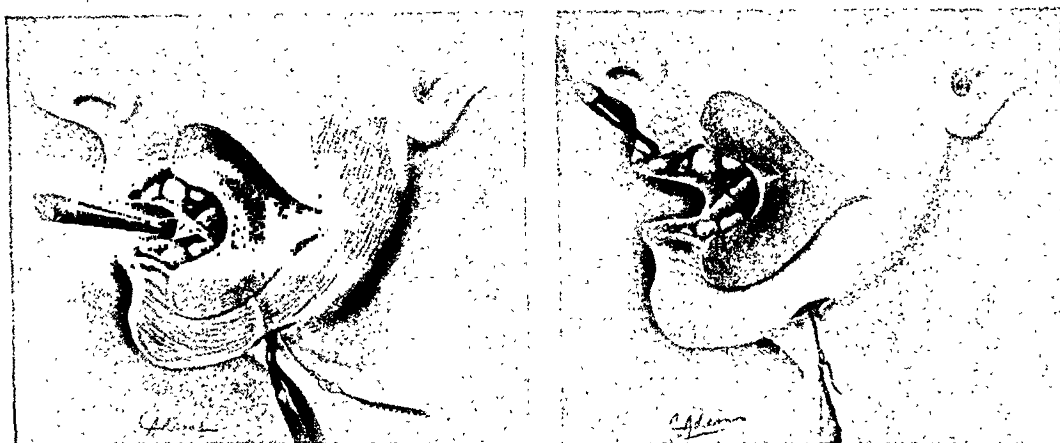


Fig. 191.—Malunion. *Left,* wire, introduced on a pedicle needle, will be used to draw the Gigli saw around the bone at the site of the malunion; *right,* Gigli saw in use.

Nonunion, with Loss of Substance in General

A bullet traveling at high velocity generally shatters compact bone, such as the mandible, but it may completely remove a segment. A partially spent bullet, or a small fragment of a shell or hand grenade, on the other hand, may cause considerable shattering of the bone without much actual displacement and loss. The primary loss of bone may not be great, but a considerable gap may result later from infection followed by osteomyelitis and sequestration. Losses of large portions of bone of the mandible can be replaced by the use of bone grafts.

Bone grafting for defects of the maxilla are not of equal value to grafts inserted in the mandible and are seldom indicated. These repairs or reconstructions can best be accomplished with lined, soft tissue, pedicled or tubed flaps (p. 253). Cartilage can be implanted before or after the transfer of the tissue giving contour, bulk, and stabil-

ity to the parts. Artificial appliances should be employed when surgical repair is not feasible (Figs. 225, 233, 234).

Bone Graft for Loss of Substance of Mandible

It is often necessary to supply new bone from other sources in cases of fracture of the mandible if union does not take place by spontaneous regeneration of bone after a reasonable period of fixation of fragments. Statistics from the war of 1914–1918 indicate that about 11 per cent of gunshot fractures of the mandible result in nonunion and that bone grafting is required. The nonunion is caused principally by the large loss of bone and the inability of nature to bridge the gap when the collapsed fragments are drawn apart and fixed in proper position. In early treatment of fractures if proper fixation of fragments is accomplished and all viable bone particles are conserved, in cases of comminution, the necessity for bone grafts later is greatly reduced.

Primary *object of treatment* is the restoration of function. To accomplish this the former occlusal relation of the remaining teeth should be established and any loss of continuity of bone restored. It is never desirable to sacrifice the occlusion of the teeth to obtain union of the fragments. (This is especially true when good and serviceable teeth remain in the fragments.) This cripples the masticatory function and increases external deformity.

In cases of loss of substance of the mandible, preliminary treatment is applied to all adjacent fractures of which spontaneous union is expected. The fragments must be reduced and fixed in such position that normal occlusion of the remaining teeth is restored. All definite *foci of infection* should be eliminated. The removal or elimination of adjacent foci of infection, such as roots of teeth projecting into the seat of the fracture, other teeth showing evidence of periapical and periodontal disease, bony sequestra, metallic foreign bodies, and infection in the soft tissues overlying the seat of fracture is imperative. No operation to restore continuity of bone should be attempted until all evidence of infection and suppuration has subsided and a suitable period of time has elapsed after the closure of sinuses and septic wounds (three months).

Reduction is accomplished in cases of nonunion by manipulation and immediate insertion of a previously made splint which fits on the teeth and maintains the normal occlusal relationship. It is possible, occasionally, to fix the fragments by means of wire ligatures attaching the lower teeth to the upper, when a sufficient number of sound teeth are present. Types of splints and methods of wiring are de-

scribed in detail elsewhere (pp. 272, 291, 322). The particular type of splint employed depends, in large degree, on the part of the mandible involved and on the relationship of the teeth present.

If the presence of *fibrous adhesions* prevents the manipulation of fragments into proper position for the application of splints, the adhesions should be severed to permit their application. Since bone grafting is contraindicated as long as there is any possibility of contamination of the wound with oral secretions, severing of adhesions intra-orally before application of splints would defer grafting operations several weeks. This can be avoided in some instances by the gradual reduction of fractures to facilitate the application of splints. A similar circumstance exists in case of bony union of the fragments with loss of substance. The preliminary operation in this case consists in cutting through the bony union with a chisel or Gigli saw. This preliminary operation requires cutting through the oral mucosa in nearly all cases. Bone grafting must be deferred until complete healing has occurred.

Types and Methods of Bone Grafting of Mandible

Restoration of continuity was accomplished in many cases in the war of 1914–1918 by employing a *pedicled graft* taken from the mandible itself. This method was first described by Bardenheuer in 1893, and was made widely known by Cole, of London. This method has had little use recently because it was found that it produced undue distortion of the soft tissues of the floor of the mouth and neck and is not suitable for large losses of bone, especially in the region of the angle and ramus of the mandible. It is considered also that the *cortex of the tibia* is unsuitable as a source of bone graft for the mandible, because of its extreme density and consequent resistance to penetration of new blood vessels in the process of consolidation. Fracture of the tibia after removal of a thick graft is not unknown. *Rib grafts* have sometimes been used for these defects, but they are usually too thin.

During the past twenty years the two methods have been (1) the *osteoperiosteal method* of Delagenière and (2) the *use of bone from the crest of the ilium*. Each has fairly definite indications.

Bone Graft of Mandible by Osteoperiosteal Method of Delagenière (Fig. 192)

Advantages.—The graft contains all the necessary elements for regeneration; it is flexible; it is easily adjusted to the size and shape of the defect; the technic of its removal and application is simpler

than that in any other method; it produces no disability at the site of removal.

Disadvantages.—A longer time is required for consolidation and recovery of normal function than by other methods. It cannot be depended on for maintenance of mandibular fragments during organization. This form of graft can be utilized for repair of losses of any extent but we prefer to limit its use to losses not exceeding ¾ inch (2 cm.) and to cases in which there is little change in facial contour.

Technic.—The procedure is divided into three stages.

STAGE 1. ANESTHETIZATION OF PATIENT AND PREPARATION OF BED FOR GRAFT.—Etherize the patient, preferably through an intratracheal tube introduced through the nose, without disturbing the fixation apparatus on the teeth stabilizing the fragments and holding them in proper position.

Over the site of the bony defect, make a curved incision through the skin, adequate in length and convex side downward. Dissect the included skin flap upward. Turn up a second flap consisting of the soft tissues covering the bone. Carefully remove all scar tissue, to expose thoroughly the ends of the fragments of bone. Extreme care to avoid opening into the buccal cavity must be exercised. The operation must be abandoned if this accident occurs. Prepare a pocket, or cuff, around the end of each fragment by carefully stripping the periosteum and soft parts away from its inner, outer, and under surfaces for a distance of at least ⅜ inch (1 cm.) (Fig. 192, *d*). Freshen the exposed bone by trimming with a rongeur forceps.

Control hemorrhage in the usual manner and place warm, moist gauze packs in the cavity while the graft is being taken and prepared. In case of excessive oozing, the gauze pack can be moistened with 1:5000 to 1:10,000 epinephrine solution.

STAGE 2. REMOVAL OF GRAFT.—Make a longitudinal incision of desired length through the skin, down to the periosteum. Expose the anteromedial surface of the tibia. Outline the graft to be removed, usually about 4 inches (10 cm.) long and ¾ inch (2 cm.) wide, by incision through the periosteum (Fig. 192, *a*). Carry this outlining incision into the bone to a depth of $\frac{1}{32}$ to $\frac{1}{16}$ inch (1 to 2 mm.) with a broad, thin chisel held perpendicular to the surface (Fig. 192, *b*). Remove the bone and periosteum included in the incision. Use the chisel, bevel toward bone, held nearly horizontal (Fig. 192, *c*). Cut the graft into the lengths desired. Close the skin incision.

STAGE 3. APPLICATION OF GRAFT.—Insert one piece of the graft, periosteal surface away from fracture, with its ends in the subperios-

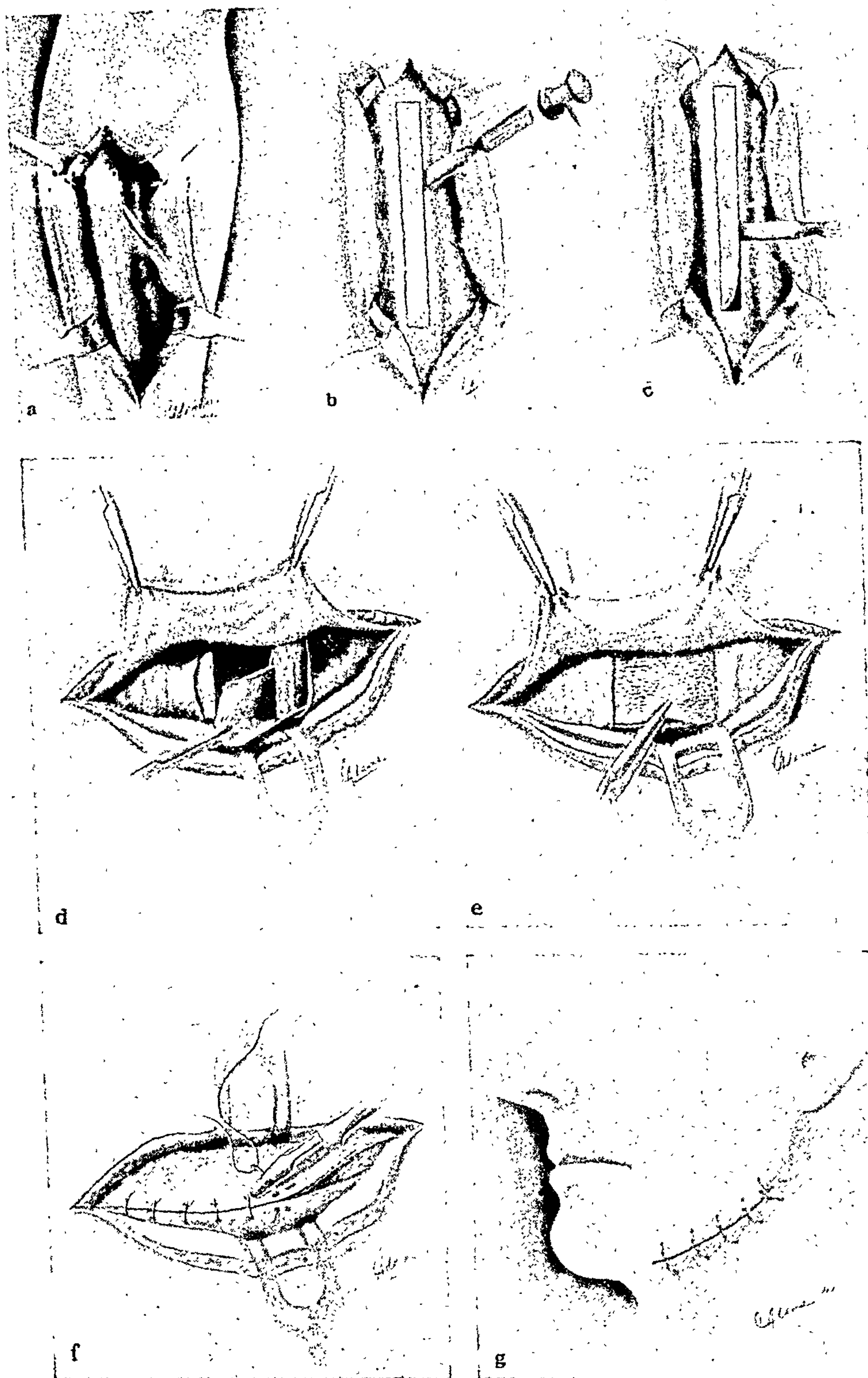


Fig. 192.—Osteoperiosteal method of bone graft for repair of mandible. a, Exposure of tibia; outlining incision for the graft through the periosteum; b, outlining incision carried into the bone with broad, thin chisel; c, removal of graft with chisel; d and e, insertion of graft, periosteum outward; f, closing deep tissues with interrupted catgut sutures; g, skin flaps closed with fine sutures.

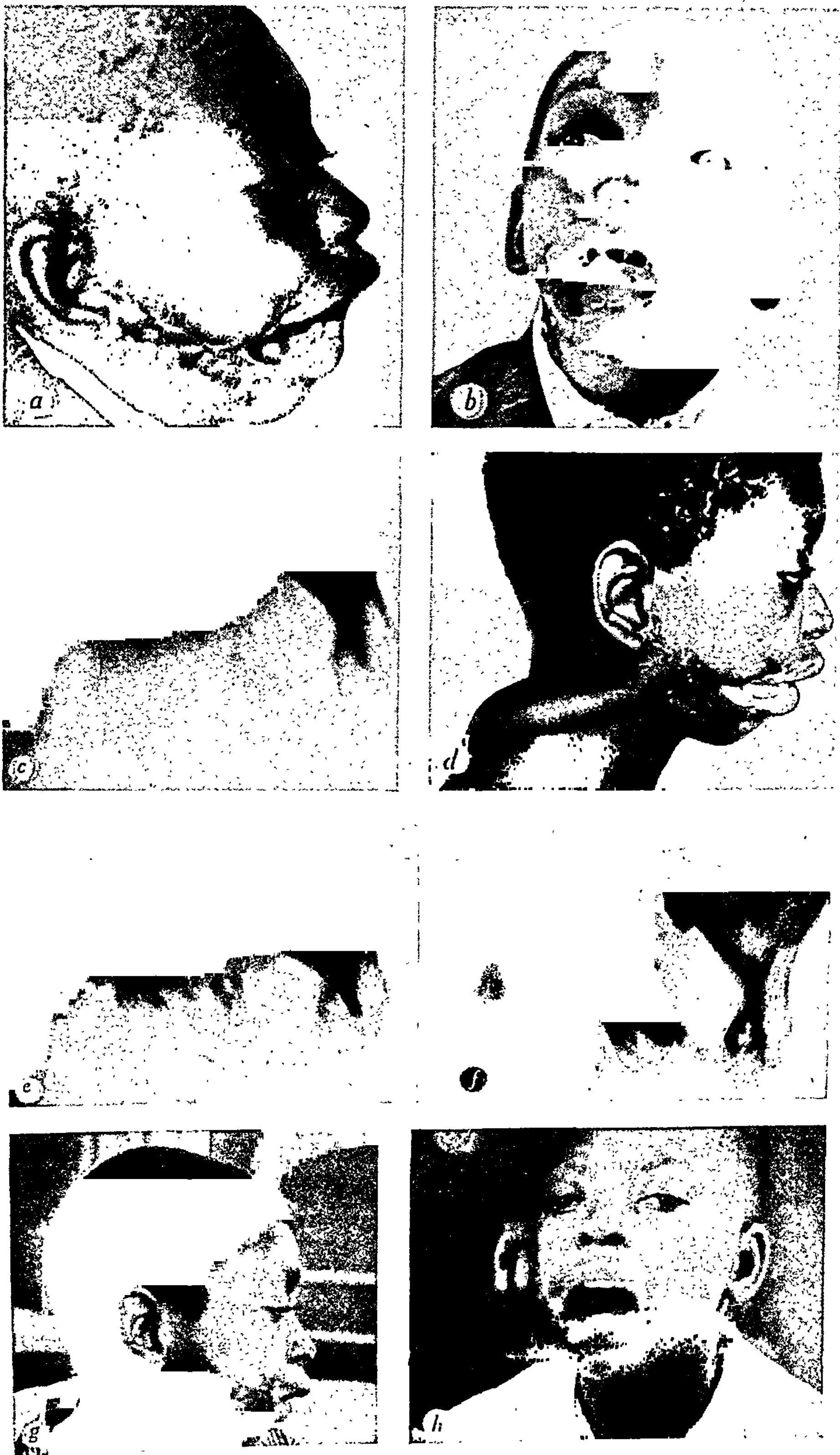


Fig. 193.

teal pockets on the inner (lingual) sides of the mandibular frag ments (Fig. 192, *d*). Insert a second piece of graft in a similar man ner on the external (buccal) surface of the fragments (Fig. 192, e) The bone surfaces of the two grafts now face each other across th gap. A third piece of graft may be placed along the undersurface o the fragments, if desired. Make certain that the bone of the graft makes contact with the raw surfaces of the fragments. Close the dee tissue flap over the grafts with interrupted catgut sutures (Fig. 192 *f*). Close the skin without drainage (Fig. 192, *g*). Apply a pressur bandage to immobilize the parts.

Postoperative Treatment.—The wound usually heals by first in tention. Remove the skin sutures on the second to fourth day an support the wound with gauze strips applied with collodion. Collec tions of serum are drained by opening the edges of the skin. Avoi insertion of a drain if possible.

Occurrence of suppuration in the soft parts may involve the graft and healing may not occur until the graft is extruded. Treat th suppurative process with appropriate chemotherapy, internally an locally. *Sulfathiazole powder* dusted or packed into the wound ma promptly check the process. Resort to the usual local measures indi cated.

Fixation of the jaws must be maintained until consolidation i well advanced; this requires at least eight weeks. Regeneration ca be checked by roentgenologic examination at monthly intervals, bu the final test of consolidation is clinical examination after disconnec tion of the upper and lower teeth.

Illustrative Case.—The steps and the results in a case of gun shot wound in which the osteoperiosteal method was used are repre sented in Fig. 193.

Bone Graft of Mandible by Graft from Crest of Ilium

This procedure was first used in Germany by Lindemann, an was the method of choice of Gillies and his co-workers at the Queen' Hospital at Sidcup, England. Risdon and Ivy and Epes have describe results of treatment by this method. This type of graft is preferred i the loss in the mandible exceeds ¾ inch (2 cm.) and, especially, i the external contour of the face gives evidence of the deficiency

Fig. 193.—Osteoperiosteal method of bone graft for repair of mandible also use of flap from back for repair of cheek. *a*, Side view, showing result o gunshot wound of right cheek; *b*, front view; *c*, roentgenogram, showing loss o bone of right side of mandible; *d*, second stage of repair of cheek by flap fro back; *e*, roentgenogram, showing beginning consolidation of osteoperiosteal graf from tibia; *f*, roentgenogram showing consolidation of graft practically complete *g*, final result of repair of cheek by flap from back; *h*, end-result.

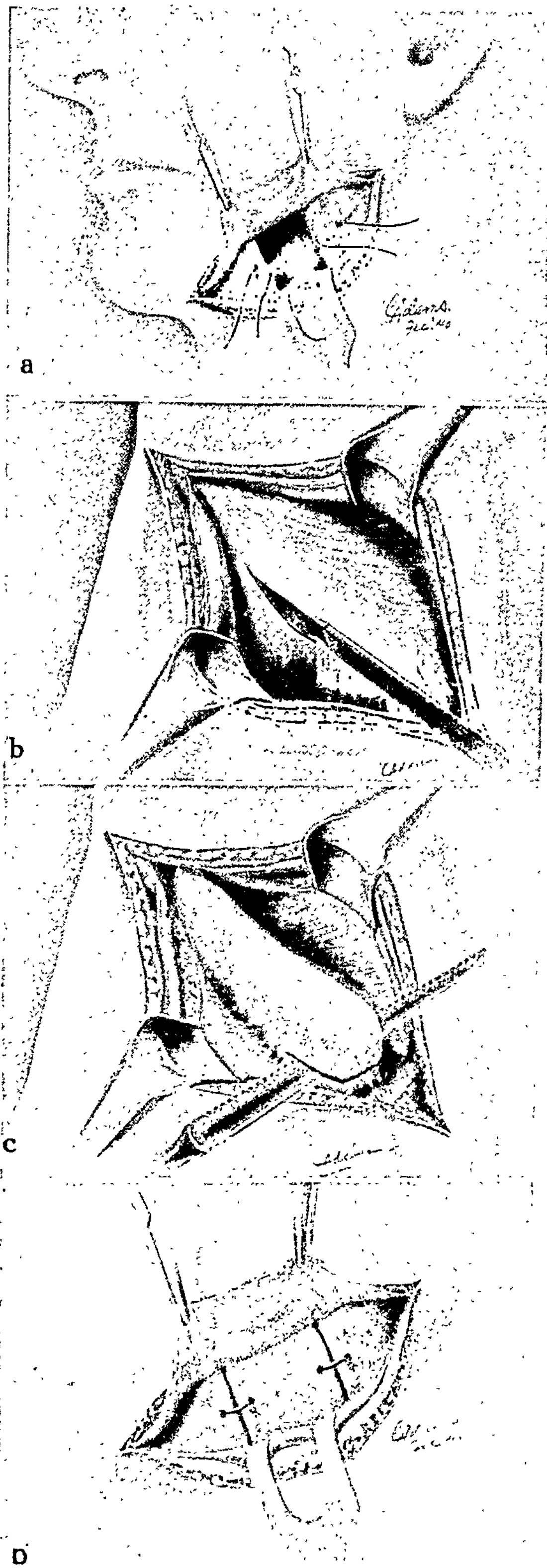


Fig. 194.—Repair of mandible by graft from crest of ilium. *a*, Preparation of site, wires in position for insertion of graft; *b*, exposure of crest of ilium; *c*, removal of graft with metacarpal saw; *d*, graft inserted.

The crest of the ilium furnishes a large piece of bone of porous structure closely resembling that of the mandible. It is easily penetrated by new vascular supply and can be cut readily to suitable shape. The disability produced by removal of the graft is temporary and the danger negligible.

Technic.—This is divided into three stages.

STAGE 1. ANESTHETIZATION OF PATIENT AND PREPARATION OF MANDIBULAR SITE.—Etherize the patient, preferably through an intratracheal tube introduced through the nose, without disturbing the fixation apparatus on the teeth stabilizing the fragments and holding them in proper position.

Make an adequate, curved, skin incision, convex aspect downward, over the site of the bony defect. Dissect upward the included skin flap. Turn up a second flap consisting of the soft tissues covering the bone. Carefully remove all scar tissue to expose thoroughly the ends of the bone fragments. Extreme care to avoid opening into the buccal cavity must be exercised. The operation must be abandoned if this accident occurs. Prepare a pocket, or cuff, around the end of each fragment by carefully stripping the periosteum and soft parts away from its inner, outer, and under surfaces for a distance of at least 3/8 inch (1 cm.) (Fig. 192, *d*). Bevel the ends of the fragments of bone to produce a broad, fresh surface. Drill a small hole in the end of each fragment for the passage of a fixation suture of wire or gut (Fig. 194, *a*).

Measure the length of the required graft with a probe. Control bleeding and place warm gauze packs in the cavity while the graft is taken and prepared. If oozing is excessive, the gauze packs can be moistened with epinephrine solution, 1:5000 to 1:10,000.

STAGE 2. REMOVAL OF GRAFT.—Make an incision down to the periosteum along the iliac crest on the same side as that of the mandibular defect. Separate the muscles from the external and internal lips of the crest (Fig. 194, *b*). Remove a piece of bone of the desired size with a metacarpal, or motor-driven, saw (Fig. 194, *c*). Begin at the anterior superior spine and work backward. The graft comprises the full width of the crest and should be of sufficient length and depth to fill the mandibular defect and to approximate the prepared surfaces of the fragments. Approximate the detached muscles over the defect in the bone with interrupted catgut sutures. Insert a drain for serum, if indicated. Close the skin.

STAGE 3. APPLICATION OF GRAFT.—Remove any shreds of muscle but leave the periosteum on the graft. Drill a hole in each beveled end of the graft. The surgeon may find it easier to drill these holes

before the graft has been removed from the ilium. Pass wires (24 gauge brass or stainless steel) through the holes in the mandibular fragments and the graft. Twist the wires until the graft approximates the fragments firmly. Cut the twisted wires short and bend the ends against the bone (Fig. 194, *d*). Secure the soft tissue flap with interrupted sutures of catgut. Close the skin with interrupted sutures.

The *postoperative treatment* is the same as that described under the osteoperiosteal method.

Illustrative Case.—A brief description of a case illustrating application of the principles just laid down is relevant here.

A man was shot with a pistol of large caliber. The bullet entered the left side of the face, shattering the left side of the mandible and remaining lodged in the tissues (Fig. 195, *a*). Shortly after the accident an operation was performed for removal of detached teeth, fragments of bone, and the bullet, and a cast metal splint was inserted in the mouth to hold the fragments in position.

Seven months after the injury the patient was referred for further treatment. A gap of about 1½ inches (about 3.8 cm.) was found on the left side of the mandible at this time. This defect extended from posterior to the left first incisor tooth to about the second molar region. There were no teeth in the fragment of bone posterior to the defect. Only four teeth were present in the main mandibular fragment. The metal splint was still in position and a saddle resting on the gum kept the short posterior fragment down in place. Ulceration of the overlying soft tissue from undue pressure was present. On removal of the splint the main mandibular fragment was found to be freely movable and showed a tendency to swing over to the left side, throwing the teeth out of occlusion and causing marked external deformity (Fig. 195, *b*).

The metal splint was discarded, and the remaining lower teeth were brought into correct occlusion with the upper teeth and fastened by means of half-round wire arches. The short posterior fragment was prevented from tilting upward by wire passed through the left angle and connected to a hook on a plaster-of-paris head cap (Fig. 195, *c*, *d*).

One week later the gap in the mandible was filled by a bone graft from the crest of the ilium (Fig. 195, *e*). The head cap and traction wire were removed five weeks after the bone-graft operation. Fifteen weeks after insertion of the graft the wires connecting the teeth were cut, and bony consolidation was found to be practically complete. The patient could open the mouth without lateral devia-

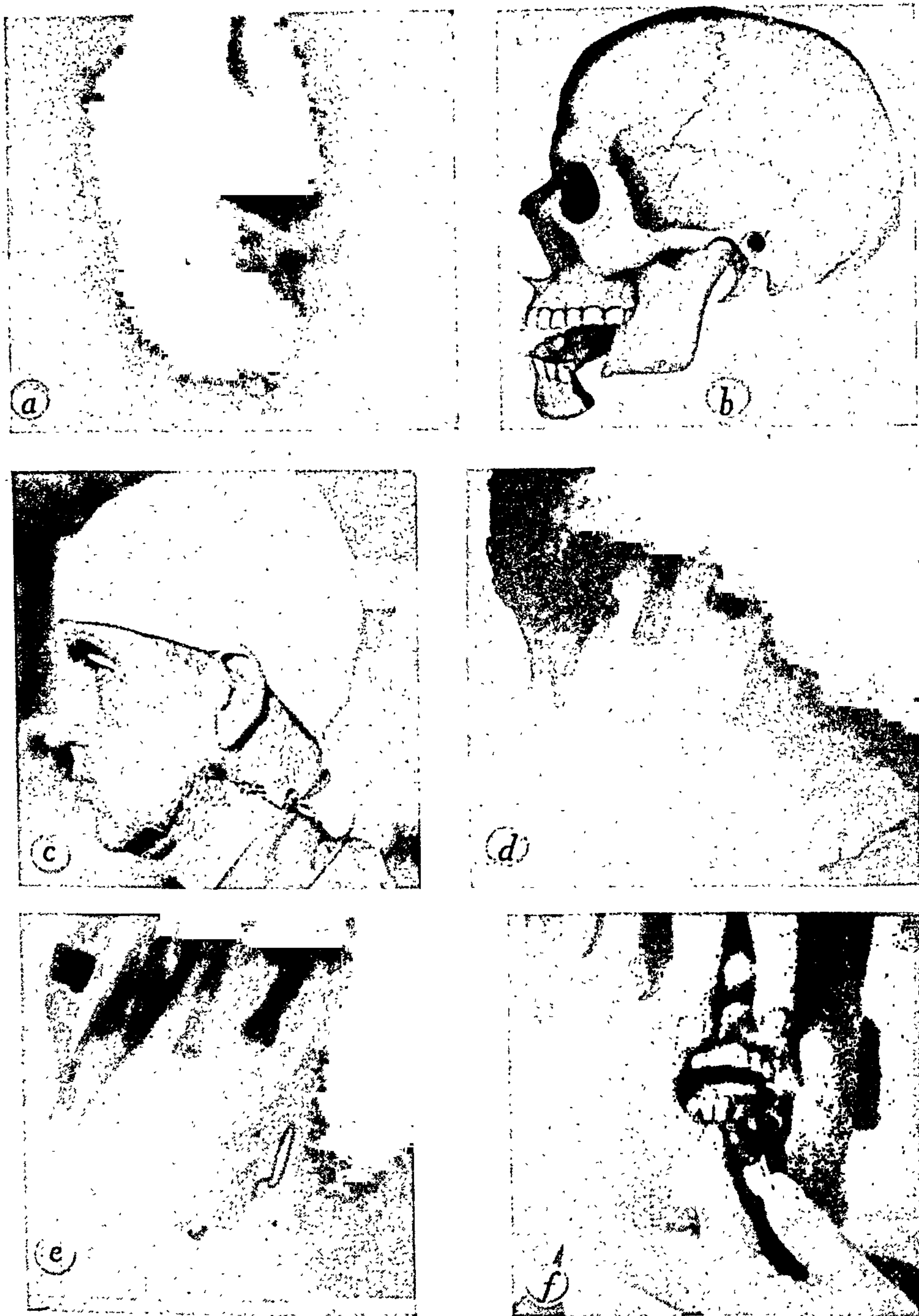


Fig. 195.—*a*, Comminuted gunshot fracture of left side of mandible; *b*, diagram of lateral mandibular defect, showing displacement of fragments; *c*, plaster head cap and traction wire from posterior fragment; *d*, roentgenogram showing traction wire holding posterior fragment in position; also, extent of mandibular defect; e, roentgenogram showing bone graft from crest of ilium filling defect of mandible; *f*, patient after restoration of continuity of mandible, showing extent of oral opening and no lateral deviation of lower jaw.

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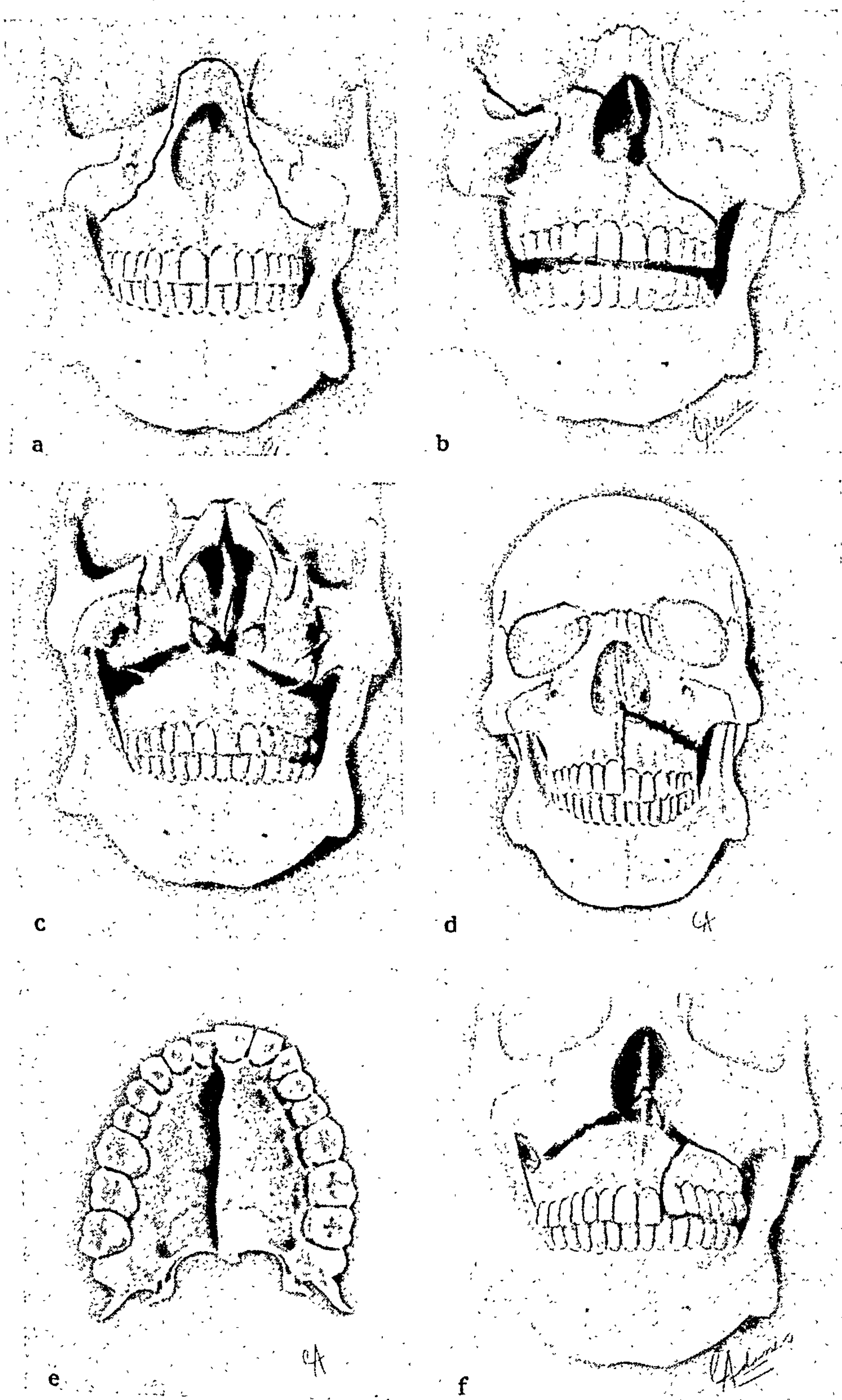


Fig. 196.—a through *f*, Facial bones involved in connection with fractures of the maxillae.

tion of the mandible, and the jaw was in condition for early insertion of an artificial denture (Fig. 195, *f*).

FRACTURES OF MAXILLA

Fractures of the maxilla are associated frequently with serious injuries to the bones of the face and head. There may be severe and dangerous complications involving the nasal fossae, the sinuses, the orbit, and intracranial structures (Fig. 196, *a, b, c, d, e, f*).

The fragile bones attaching the maxilla to the base of the skull may be crushed or destroyed as the result of a gunshot wound or severe trauma from below, leaving the maxilla freely movable and held only by soft tissue. A rigid appliance to maintain the proper distance of the upper jaw from the base of the skull may be essential. The United States Navy Dental School has developed an apparatus suitable for this purpose. Other means, such as wires coming down in front of the face from a head cap, the wires connecting with a splint on the teeth, can be improvised.

General anesthesia may be necessary for reduction of extreme displacement associated with fractures before application of the fixation apparatus. This part of the management of a fracture of the jaw can be instituted soon after the patient's admission to general hospital, before permanent repair of the soft parts is possible. Repair of soft parts must await subsidence of infection therein and in the bone. Various operative measures for repair of soft tissue have been discussed in detail in Section I, "Reconstructive Surgery."

The desired result in cases of bilateral transverse fracture of the upper jaw, with backward displacement, may have been accomplished by the time of the patient's arrival at the general hospital if forward traction by means of one of the methods previously described ("Tongue-Depressor Method," p. 277, or "Coat-Hanger Method," p. 278) has been applied. Fixation of the upper and lower teeth in occlusion may be all that is necessary to complete the treatment. This can be accomplished with multiple loop wiring and elastic bands according to the amount of stability required in the individual case.

Displacement

Displacement of fragments in fractures of the maxilla is not necessarily due to muscular pull, owing to absence of powerful muscular attachments, but rather to the traumatizing force and to gravitation (Fig. 197).

Unilateral Fracture of Maxilla.—This is caused usually by direct force coming from in front or from one side. The entire maxilla on

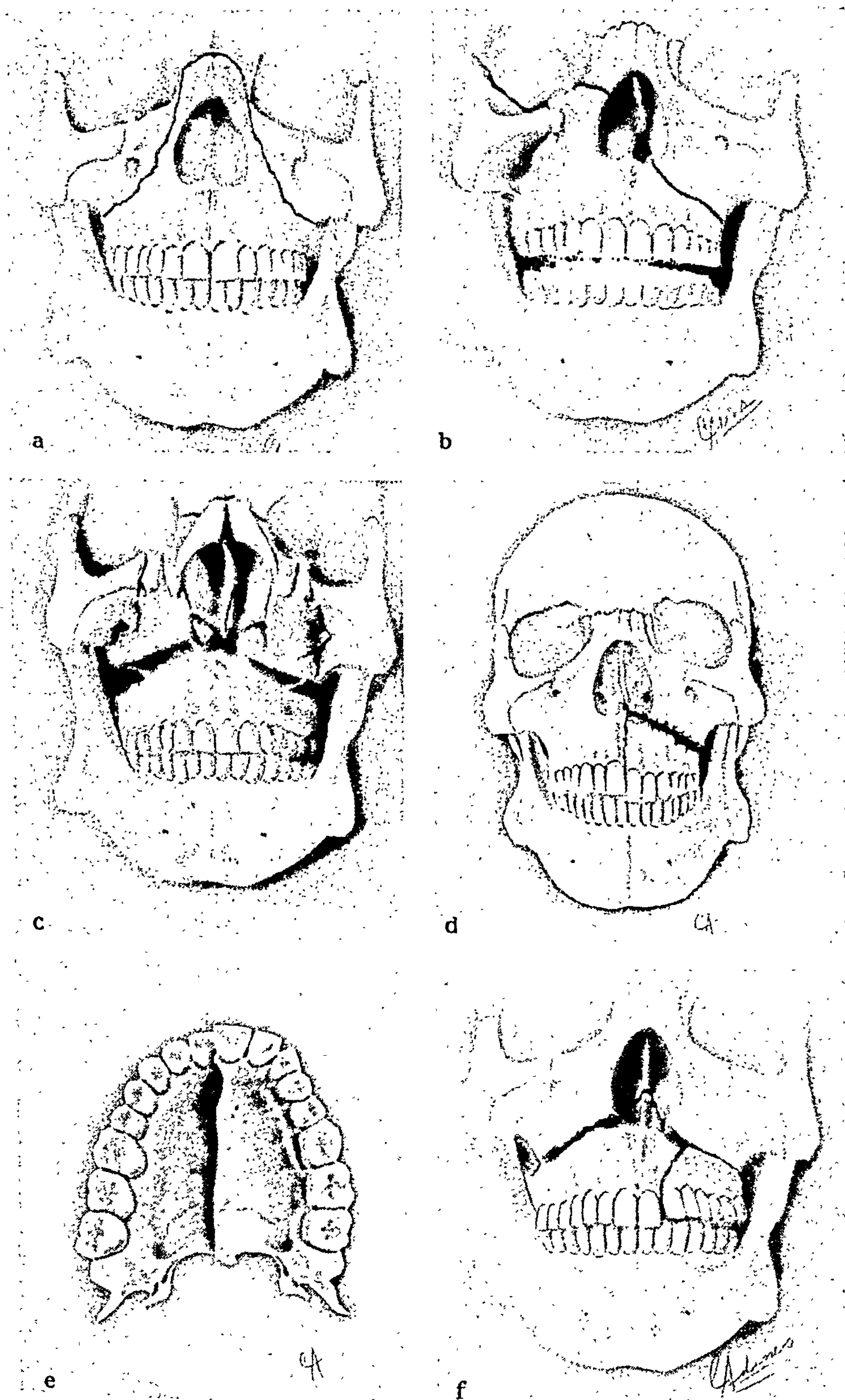


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CONSTRUCTION OF PLASTER-OF-PARIS HEAD CAP

The late Captain C. W. Scogin, Dental Corps, U. S. Army, described the construction of a very satisfactory plaster head cap somewhat as follows:

Materials Necessary for Construction

1. Stockinet: 3 inches by 2 feet or about 8 by 60 cm. Three-inch stockinet is 6 inches (15 cm.) in circumference and capable of considerable stretching. If not available, any substitute can be used, such as a leg from a pair of balbriggan drawers or a heavy white stocking.
2. Narrow gauze bandage or tape: 1 foot (30 cm.) long.
3. Adhesive plaster: 1 inch (2.5 cm.) wide.
4. Orthopedic felt: 4 (or more) strips measuring 1½ by 6 inches (3.8 by 15 cm.). If not available, use strips of heavy cotton batting or several layers of an old felt hat.
5. Plaster-of-paris bandage: 2½ inches by 10 feet (6 cm. by 3 meters). Two of these are necessary.
6. Plaster of paris: good quality model plaster, large plaster bowl, and heavy spatula.
7. Traction appliances: leather straps and buckles, hooks, loops, webbing, and so forth, as indicated. Hooks can very conveniently be made from an ordinary wire coat-hanger.
8. Scissors: bandage scissors for felt, small scissors for other materials.

Outline of Areas of Head to Be Utilized

The direction of stress must necessarily determine the area of anchorage. In general, the finished margins of the case should extend:

1. In the occipital region well over the external occipital protuberance toward the base of the skull.
2. In the mastoid region as close as possible to the ears but not encroaching on them.
3. In the temporal region to about the zygomatic arch; definitely below the parietal eminences.
4. In the frontal region care must be exercised in freeing the forehead to about 1 inch (2.5 cm.) above the line of the eyebrows.

Steps of Construction

1. Seat the patient in a straight-backed chair without a head rest.
2. Clip the hair of men if lengthy fixation (two or more months)

the affected side sags and may be forced inward with overlapping of the palatine suture. Occasionally, the fragment will be forced outward, causing spreading of the midpalatine suture.

Bilateral Horizontal Fracture.—This is caused usually by direct force from in front, such as that exerted when the face strikes the

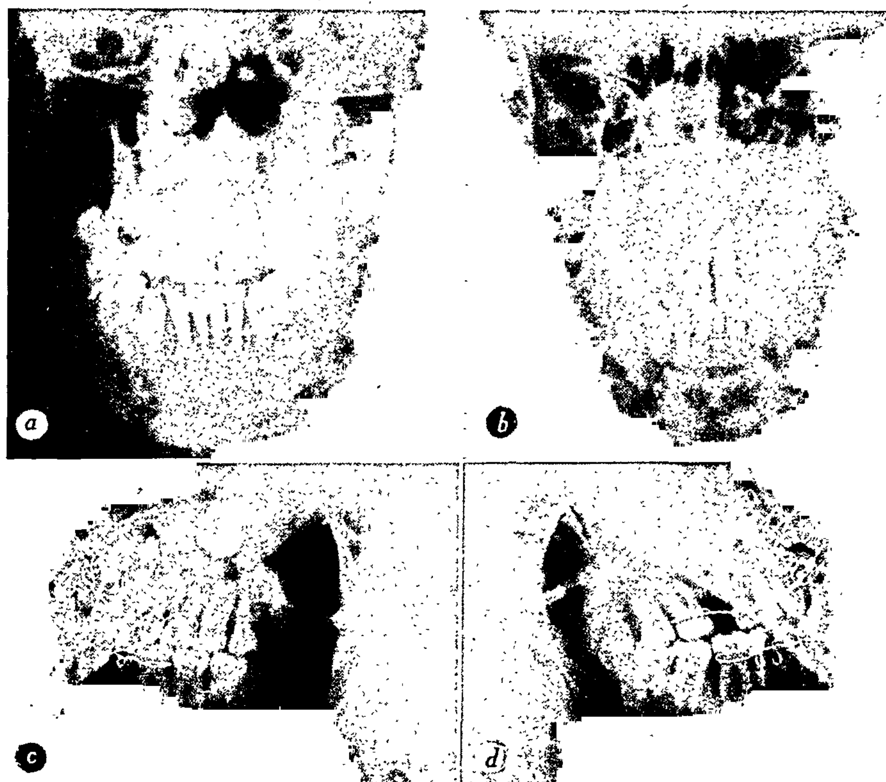


Fig. 197.—*a,* Fracture of the maxilla, compound, complete, through the lateral and medial walls of the maxillary sinuses and nasal structures; displacement distally and to the right; fracture of the mandible, compound, region of right canine and left canine teeth; fragment displaced distally; simple fracture of neck of condyloid process, left side; *b,* lower arch restored to former contour in early treatment and superior maxillary fracture reduced and immobilized later by application of intramaxillary multiple loop wiring, using elastic bands for intermaxillary traction and fixation; *c* and *d,* former occlusal relation of right and left sides restored; also, fracture of left zygomatic arch reduced.

framework of a suddenly arrested automobile or airplane. The force carries backward the entire maxilla, somewhere above the level of the palate, and gravity causes it to sag posteriorly. The posterior upper and lower teeth can be brought together, while there is an open bite in front. The upper anterior teeth are found to be distal to their normal or original position.

will be required; otherwise clipping is not considered necessary. Have women braid the hair and arrange in loose coil on top of head.

3. Apply one end of stockinet over the head to a point 2 inches (5 cm.) below a previously determined border outline of the finished head cap (Fig. 198, *a*).
4. Tie narrow bandage or tape loosely around the stockinet at the top of the head so that the loop will be about 2 inches (5 cm.) in diameter.
5. Cut a slit in the stockinet and push the tied ends of tape through to the inside. This is done so that the stockinet can be tightened during later steps if necessary.
6. Cut and adjust felt strips, one or more vertically in each quadrant, and fasten in place on the stockinet with adhesive plaster.
7. Pull the free end of the stockinet down over the head and trim it just short of the length of the first layer. Felt strips are now between layers of stockinet. There is a small opening at the top of the head in which the ends of the tape are found (Fig. 198, *b*, *c*).
8. Apply the first plaster bandage as follows: Wet a bandage in lukewarm water and apply as a head bandage over the stockinet; keep the bandage wet, and smooth it into place with wet hands, being certain to obtain the desired outline form (Fig. 198, *d*).
9. Apply a plaster wash over this layer, smoothing well with wet hands.
10. Turn up both ends of the stockinet to form a lower border for the cap, plastering the stockinet into the plaster wash.
11. Insert traction appliances as indicated; that is, straps, hooks, loops, and so forth. These must be placed to deliver the correct directional force in the individual case (Fig. 198, *e*).

Fig. 198, *f*, *g*, show how one type of traction can be applied in connection with the head cap.

MAXILLOFACIAL ORTHOPEDICS

Coordination of Specialties

The complex problems which confront surgeons in treatment of injuries of the face and jaws present a great variety of conditions, each type requiring a special method of treatment. In order to assure the most favorable end-results, the oral and plastic surgeon must have







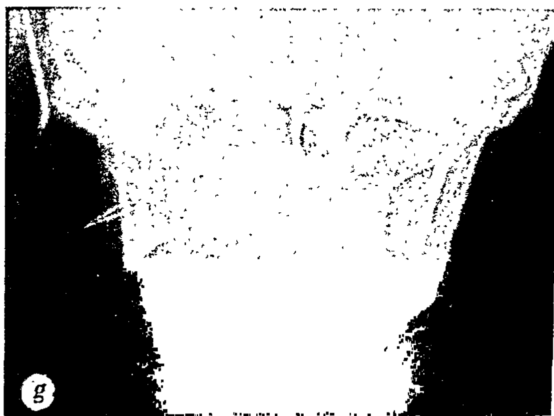


Fig. 198.—*a* through *e*, Steps in construction of plaster head cap; *f* and *g*, wire passed through angle of mandible attached to extension arm from plaster head cap.

these same forces are used in the gradual reduction of the displaced segments in order to restore original occlusion, arch form, and relations. The necessary bony changes will take place under the influence of traction. The inherent character of bone provides the essentials for change, and these can be stimulated by properly directed forces. The orthodontist has developed various types of delicate appliances for correction of malocclusion. In the field of maxillofacial orthopedics, similar appliances embodying the same principles are used to correct deformities in connection with fractures of the jaw.

Anchorage

Anchorage must be secured over a broad area. While bands cemented to teeth in each segment may afford anchorage in some cases, several teeth should be included. To immobilize segments of jaw there must be compound fixation, and this anchorage must be distributed to assure stability and to secure the control or movement desired for restoration of arch form and original occlusion. Splints and splint appliances may be described as possessing the constant factor of compound reciprocal anchorage (Fig. 199).

Bands

Bands adjusted to selected anchor teeth supply attachment for arch wires of various design. Attachment should be secured on all available teeth in each segment (Fig. 199, *a*).

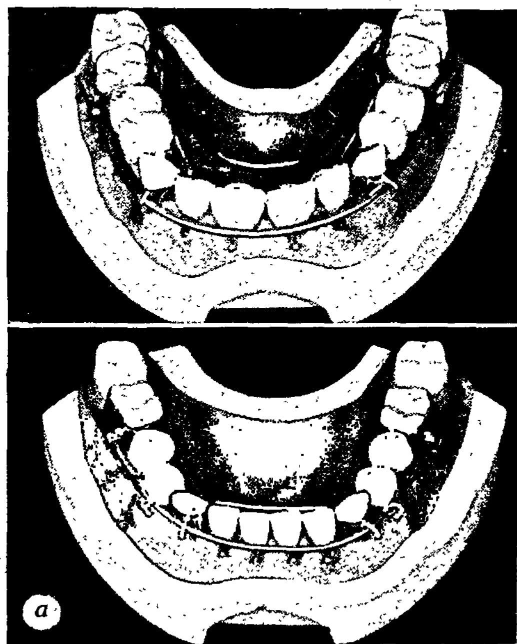
The sectional splint appliance affords the most favorable type of anchorage for a majority of cases. It offers exceptional anchorage and does not require cementation to the teeth. This is particularly important, for the appliance can be removed without danger and without irritation or disturbance of the newly repaired bone.

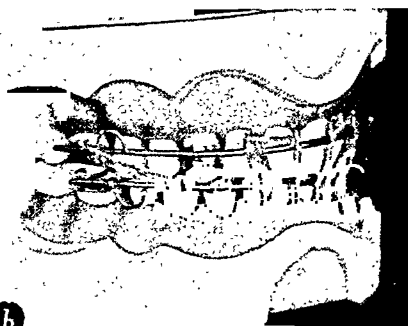
Traction Appliances

Extra-oral Traction.—It is frequently necessary to secure extra-oral traction for restoration of the original relationship of maxillary structures. This may require occipital or frontal anchorage. It can be secured in the several ways which have been illustrated in previous chapters. Such anchorage is always necessary in treatment of depressed fractures of the maxilla. With suitable anchorage, properly distributed, traction to correct displacement is applied by means of rubber bands.

Frequently the adjustment requires the application of traction with intermaxillary fixation. This is true for all those cases in which only the adjustment of the arch relation is required in order to secure restoration of original occlusion of the teeth (Fig. 199, *b*, *c*).

available specialists who are able to add their particular skill. For instance, unreduced maxillary fractures, presenting union in malposition, loose fibrous union, or loss of small portions of osseous structures, call for the assistance of the dental orthopedist. It has been soundly established that in many of these cases surgical interference is not





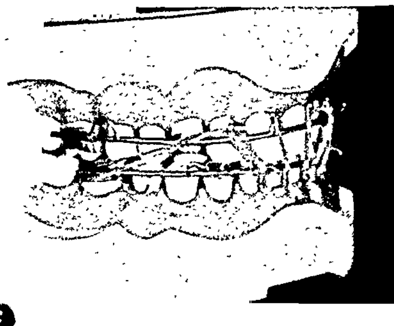


Fig. 199.—*a*, Orthodontic appliances, using bands for anchorage on upper and lower teeth; *b* and *c*, intermaxillary elastic bands used in connection with orthodontic appliances for intermaxillary traction and fixation.

required for correction of the deformities, for it is frequently possible to restore original occlusion or arch form by means of mechanical orthopedic measures. In fact, use of the mechanical principles of fixation, traction, and retention are dominant forces in restoration of the bony structures in all cases of maxillary fracture. More particularly, in treatment for old fractures, with segments in malposition,

In cases wherein osseous structure has been lost and collapse of the segments has taken place, with bony union, monomaxillary or intramaxillary traction will be necessary for correction of the deformity. The sectional splint affords great possibilities for use of the traction required to restore the fragments to their original position, reestablishing occlusion and arch form (Fig. 200, *a*, *b*, *c*).

The traction must be maintained within physiologic limits of the bony tissue. It must not be so strong as to become irritating; it must be only sufficient to stimulate bone-cell change. The cell-stimulating force (traction) brings about readjustment of the fragments or jaw segments by gradual reduction, with restoration of original relations and bony union.

Fibrous Union

The process of repair of bone is very complex. There are some interesting aspects to bony change under the influence of mechanical orthopedic manipulation. Gradual reduction under the influence of traction is accomplished as a result of transformation of the tissue itself. It must be recognized that bone is a derivative of connective tissue and that the characteristics of its connective-tissue origin dominate all the problems of its growth, regeneration, and repair. Loose fibrous union in cases of old fractures of the jaw can be treated by traction appliances, thus changing the character of the repaired tissue, reestablishing normal relations, and stimulating the normal tissue transformation, with resultant bony repair (cleft palate molded during infancy; alveolar cleft or anterior displacement of premaxilla in double clefts molded into position by closure of the lip). An orthodontic example is lateral expansion.

Loss of Bone

In cases of mandibular wounds, with loss of small amounts of bone and with collapse of segments or fragments, restoration of arch form and original occlusion can be accomplished by slow reduction. Sectional splints provide facilities for special intramaxillary traction.

Fig. 200.—*a*, Injury from ricocheting bullet, involving the mandible from right central incisor to first molar; marked comminution of bone and scattering of tooth fragments; also, marked collapse of lateral segments attributed to delay in treatment and loss of substance; *b* and *c*, elastic traction from hooks or loops on overlapping extension arms, anchored to orthodontic bands on the right side and cast-silver sectional splint on the left, used to expand the arch to its normal contour; intermaxillary elastic bands to multiple loop wiring were used to assist in restoring the teeth to their former occlusal relation; irregular radiopaque areas are thin pieces of lead in the sof[illegible]

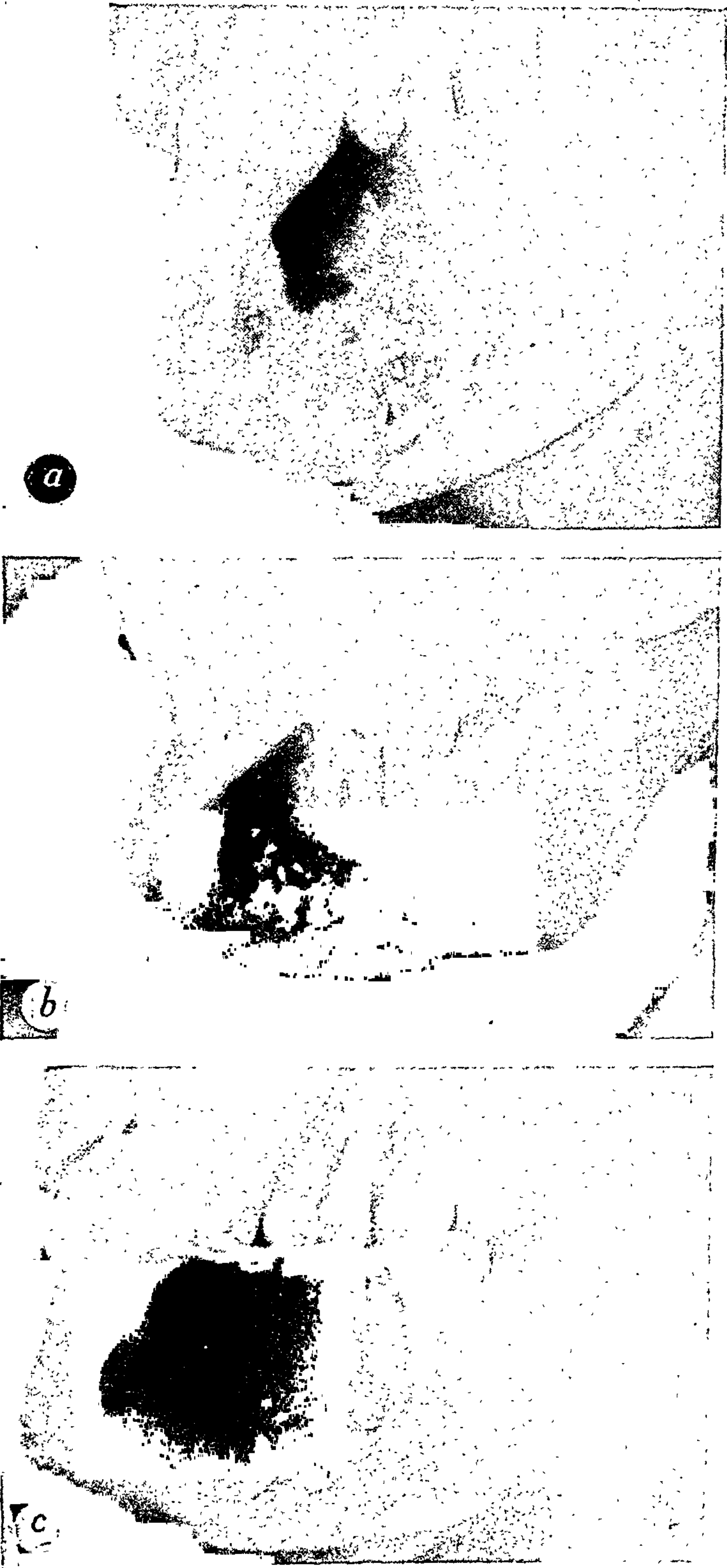


Fig. 200.

splint at all times. The acrylics possess another very great advantage in that they are radiolucent. For this reason roentgenograms can be made with the appliance in place and, as the acrylic material casts no shadow, there will not be an obliteration of detail by the splint. *Vulcanite* and *silver* are neither transparent nor radiolucent. Vulcanite permits great ease of construction, which is perhaps its only advantage. The use of silver is sometimes indicated. It is much stronger than the other materials, and for this reason the splint may be made much less bulky without sacrificing strength. However, the more difficult process of casting and finishing must be regarded as comparative disadvantages.

Impression Compounds.—The first requirement in the construction of a successful splint is a good stone model of the remaining teeth and adjacent tissues of both the maxilla and mandible. One of the hydrocolloid impression materials is the material of choice for taking the impressions, from which the models are made. Plaster of paris can be used but, as accuracy is of paramount importance, modeling compounds and materials which are subject to distortion are not recommended, unless an exacting sectional technic is employed. The splint never should be constructed on the original model but on one or more duplicated models. In making the splint an accident might occur, necessitating a new start, but this would be comparatively simple provided the original model was intact. The original, or master, model also will serve as a case record.

Preparing Models.—When there is marked displacement of the fragments, the impression is taken of the parts in their displaced position; no attempt at reduction is made at this time. The stone model made from this impression is duplicated. The duplicate model is cut along the lines of fracture and is reassembled with the teeth in the same occlusal relation with the opposing teeth as before the fracture was sustained. The reassembled model is then duplicated, and the actual fabrication of the splint is accomplished on this second duplicated model, or working model, as it might be called. During the casting or vulcanizing process the working model will be destroyed, but the reassembled model from which it was made will still be available for fitting and finishing the splint.

Principle of Sectional Splint.—There are numerous variations of the sectional splint, but they are all modifications or elaborations of the simple, three-piece, basic design. This splint consists essentially of one lingual segment and one buccal segment hinged distally on each side to the last tooth to be included in the splint. The buccal segment is divided into two sections by a vertical split at the median line

CONSTRUCTION OF SPLINTS

The objective in treating fracture of the maxilla or mandible is to restore the fragments of bone to their proper position and to hold them there until consolidation has taken place. The treatment must be efficient, and the comfort and welfare of the patient must always be considered. In the final result the teeth should be in their original occlusion. A large percentage of fractures can be most satisfactorily reduced by wiring, using elastic bands for traction and fixation; the preferred treatment is the simplest one that will give the desired result.

Certain conditions often encountered require more elaborate treatment than simple wiring and elastic traction. An example of this would be delayed union or nonunion of the fragments, and the treatment would necessarily be extended over a long period. Another example would be a case in which there is extensive loss of bone or collapse of the fragments, and the parts must be held in their proper positions while a graft is inserted and is undergoing consolidation. In these cases it would be most desirable to maintain function. This could be accomplished by the use of splints. Also fractures requiring gradual reduction are often best treated by use of a splint. When intra-oral extension arms, or arms for rhinoplastic scaffolding are indicated, splints may be used, as they serve as a base to which these appliances can be attached. A splint provides the maximal anchorage, with broad base, that can be obtained in one arch.

Construction of Sectional Splints

Sectional splints have some very great advantages over the old type of full-coverage splints. The occlusal surfaces of the teeth are not covered; therefore, occlusion is not interfered with in any way. The old type, or full-coverage, splints depended on cementation to the teeth for retention, and removal was difficult. As cement is not used with the sectional type of splint, application or removal is a very simple procedure. Full-coverage splints often caused considerable gingival irritation, but the sectional type of splint has almost entirely eliminated this disagreeable feature.

Materials.—Vulcanite, acrylic resin of the clear type, or silver may be used for constructing sectional splints. The clear acrylics are probably the material of choice in most cases as they possess certain desirable properties which the other two materials do not have. *Acrylic* splints are much less conspicuous and, as they are transparent, it is possible to observe the condition of the gingival tissue under the

These right-angle extensions are the means by which the wire will be held in place while the case is being packed and cured, as they will later be embedded in the investment when the case is flasked for packing. Close adaptation of the wire is not desirable except on the distal surface. A certain amount of space between the hinge and the buccal and lingual surfaces of the teeth is necessary as the wire must be well embedded in the splint material to prevent it from breaking attachment.

Making Wax Pattern.—The hinge wire and tubing, properly adapted, are fixed on the model with a little sticky wax. A wax pattern of the splint is then built, exactly as it is to be when finished, except that the buccal segment is solid. The cut at the median line, which divides the buccal segment into two sections, is not made until after the case has been cured and polished. For making a vulcanite or



Fig. 202.—*Left,* hinge connectors with right-angle extensions on model; *right,* splint pattern waxed to desired outline and contour.

an acrylic splint one and a half thicknesses of pink base plate wax will give the proper bulk consistent with adequate strength. The wax pattern of the splint is simply a band of wax around the teeth on the model; it covers about three-fourths of the buccal and lingual surfaces of the teeth, and extends over the gingival margins 1/16 or 1/8 inch (2 or 3 mm.). The right-angle wire extensions must, of course, extend beyond the surface of the wax so that later they can be embedded in the investment material (Fig. 202, *right*). The wire on the distal surfaces of the teeth should be kept free from wax, as the spring action of the wire is to be maintained. It must be understood that the wires are simply connectors between the lingual segment and the two buccal sections, that they hold the three parts of the splint together in a single unit, but also that they permit the buccal sections to be sprung outward, or opened, so that the appliance can be placed on the teeth or removed.

(Fig. 201). The sectional splint depends for retention and stabilization on its grip on the contoured portions of the crowns of the teeth. Ordinarily the middle and gingival thirds of the crowns are covered. It is neither necessary nor desirable to cement this appliance to the teeth. The splint should be extended over the gingival tissues a distance of $\frac{1}{16}$ or $\frac{1}{8}$ inch (2 or 3 mm.). This gingival extension serves as protection to the gingiva and also improves oral hygiene. A flat, undercut button about $\frac{1}{4}$ inch (0.6 cm.) in diameter is built into the labial portion of the splint at the median line. The vertical cut which divides the buccal segment into two sections passes through this button. When the splint is placed in position in the mouth, a ligature wire is passed around the halves of the button. When this wire is tightened, the two buccal sections are pulled firmly about the teeth, thus producing the grip by which the appliance is secured.

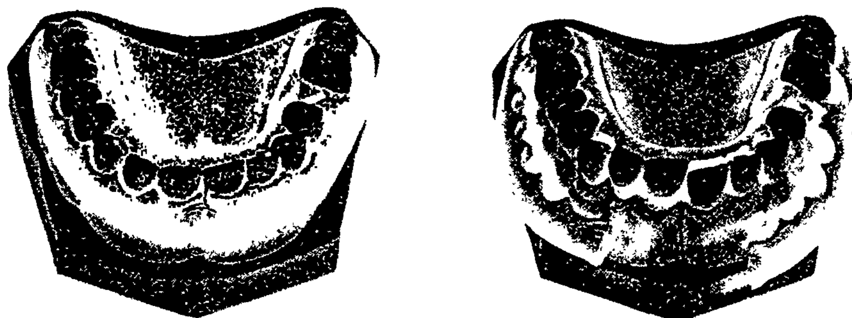


Fig. 201.—*Left,* sectional splint, closed by applying two turns of a ligature wire around the undercut button; *right,* ligature wire removed; splint released.

Adaptation of Hinge Wires.—With suitable working models prepared, the first step in the actual construction of the splint is adaptation of the wires which act as hinges or connectors. The material best suited for this purpose is 14 gauge, half round, gold clasp wire or nickel-silver wire of the same size and shape. Orthodontia band material can be used, but the half round wire is much more satisfactory. The hinge is formed by carrying the wire around the distal surface of the last tooth, to be included in the splint on each side of the mouth. The wire should be kept as far gingival as possible without impinging on the soft tissues. It is carried around on both buccal and lingual surfaces of the tooth as far forward as the mesial surface, or even farther forward if additional strength is required. At this point the wire is bent away from the tooth, at an angle of approximately 90 degrees, and is cut off about $\frac{1}{2}$ inch (1.3 cm.) from the surface of the tooth on both buccal and lingual sides (Fig. 202, *left*).

teeth will be under the wax forming the buccal segment, but as this portion of the appliance must be free to lift away from the vulcanite teeth, a separating medium must be placed between the porcelain and the wax overlying it. Tinfoil, 0.001 inch (0.00254 cm.) thick, burnished over the labial surfaces of the replaced teeth, serves this purpose very well and permits easy separation of the buccal portion of the splint after vulcanization.

Steps in Curing.—When waxing has been completed, the occlusal portions of the crowns of the teeth on the stone model are cut off flush with the wax. The case is then invested in the lower half of a flask, and 0.001 inch (0.00254 cm.) of tinfoil is carefully burnished over the wax and model as for any acrylic denture (Fig. 204). The

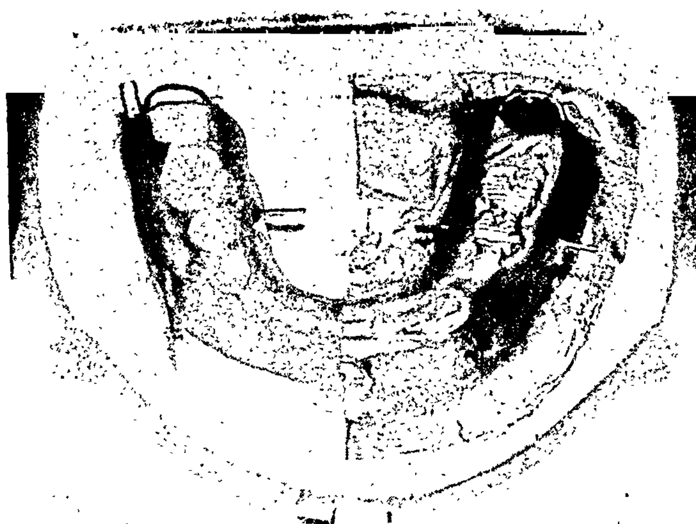


Fig. 204.—Splint pattern in lower half of flask, with tinfoil on half of it.

top half of the flask is placed in position and the investing completed. Elimination of the wax is accomplished by boiling in the usual manner. It will be found that the hinge wires are retained in the upper half of the flask because the right-angle extensions which projected beyond the surface of the wax have been embedded in the investment material. The model which is in the lower half of the flask is now covered with tinfoil, as the acrylic resins must not be permitted to come in contact with plaster and both sides of the case should be protected by tinfoil unless, of course, an investment becomes available which will eliminate the necessity for this. Packing, closing of the flask, and pressing are the next steps in order, and the splint is then cured, either by boiling or by vulcanizing, according to individual preference. Curing by boiling is perhaps the simpler process of the two, but

Management of Edentulous Portions.—Any edentulous spaces that may be present are filled with wax to within 1/32 or 1/16 inch (1 or 2 mm.) of the occlusal surfaces of the teeth adjoining the space. After the splint has been cured and polished, the material in these edentulous spaces will have to be cut vertically, from mesial to distal aspects, in order to permit the splint to be opened. These cuts, as well as the one through the button at the median line, are made with a very fine saw. If two holes are drilled through the splint material in one of these edentulous spaces, from buccal to lingual aspects, and a ligature wire is passed through them and tightened, the grip of the splint on the teeth will be materially increased at these points. The region around the openings of the holes should be countersunk so



Fig. 203.—Countersunk holes in edentulous regions for application of ligature wire.

that the twisted ends of the ligature wires will lie below the surface of the splint and the cheek will not be irritated by its rubbing against the wires (Fig. 203).

Replacing Missing Teeth.—Frequently, in cases of fracture, one or more anterior teeth are missing. It is a simple matter to replace them with vulcanite teeth attached to the splint, and this procedure is often desirable for esthetic reasons (Fig. 201). Teeth of the proper size, mold, and shade are selected and ground to fit as would be done for any partial denture, and are placed in position on the model before the wax has been applied. After the waxing has been completed, the pins and ridge lap of the teeth will be attached to the lingual segments of the splint. The labial surfaces of the replaced

14 gauge wire. Extra-oral arms and arms for rhinoplastic scaffolding are necessarily of greater length and must be made from more rigid material. The obvious solution to this is the use of material of larger

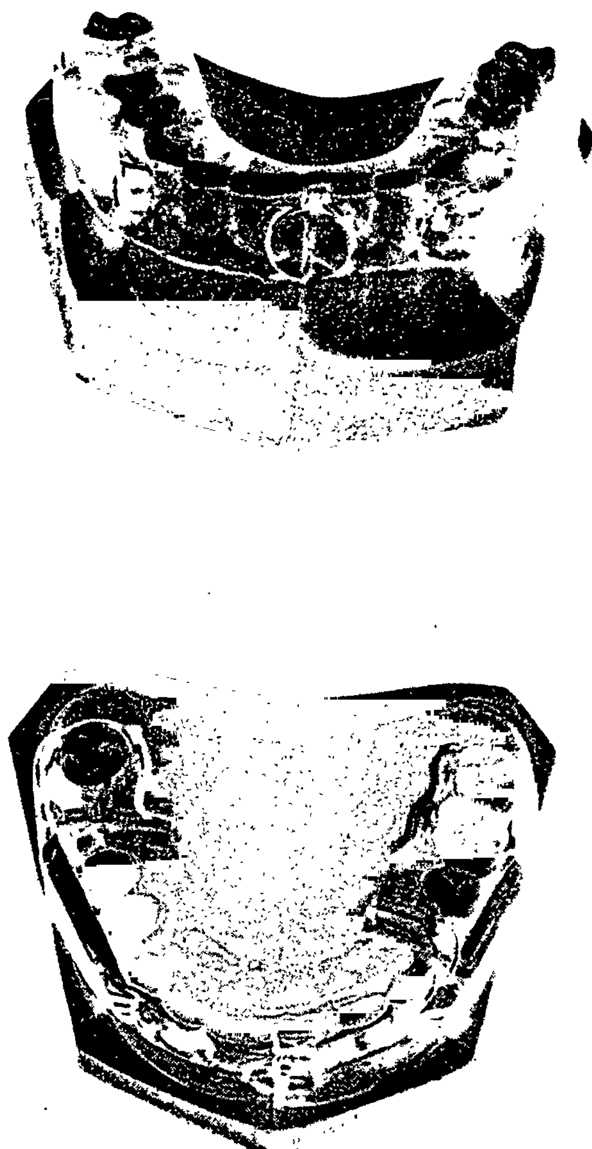


Fig. 205.—*Top* and *bottom*, clear acrylic splint with parallel square tubes on each side for anchorage of intra-oral or extra-oral extension arms.

gauge, but in some cases the added bulk might be a serious objection. Perhaps a more desirable method is to solder two tubes of small gauge parallel to each other and to insert wires in each of them (Fig. 205).

the stone model and plaster investment are not broken down by a temperature of 212° F., and it is sometimes a little difficult to remove the splint. The higher heat used in the vulcanizing process breaks down the plaster and stone, making removal of the case comparatively easy. The properties of the cured acrylic seem to be about the same regardless of which method of curing is used.

Completion.—On removal from the flask the splint is trimmed and polished; the buccal segment is divided into two sections by sawing vertically through the button at the median line, and any edentulous portions are cut through mesiodistally. The appliance is then fitted to the original model and any necessary minor adjustments are made so that it will go into place perfectly. Careless trimming must be avoided, particularly around the parts in contact with the teeth, as removal of too much material will impair the grip of the splint and reduce its efficiency.

Construction of Attachments

The foregoing has described the construction of the simple, basic splint without attachments. Extension arms, either intra-oral or extra-oral, often are required to immobilize effectively certain types of fractures. If these attachments are to be used, sections of square tubing are built into the splint and the extension arms are made of square wire which fits snugly into the tubing. After the hinge wires have been adapted, a piece of tubing is cut to the desired length and placed in position on the model. The location will vary somewhat with individual cases, but usually the tubing is placed on the buccal surfaces of the molar teeth and lies parallel to the occlusal plane (Fig. 202). Ordinarily the tubing can be soldered to the hinge clasp wire and will be held in place during packing and curing along with it. Occasionally, however, it may be necessary to place the tubing in such position that it cannot be attached to the hinge. If this occurs, it is waxed to the model in the desired location, and a wire is inserted which is long enough so that its end will project well beyond the ends of the tubing and will be embedded in the investment when the case is flasked (Fig. 204). By this method the wire is held stationary, as both its ends are buried in investment. The tubing is like a sleeve on the wire and, as it fits very accurately, there is enough frictional retention to keep it in position. The case is then waxed and carried to completion as heretofore described.

Materials.—The square tubing and wire used in making the attachments that have been mentioned are of nickel-silver. Short intra-oral extension arms usually require 10 to 14 gauge tubing and 10 to

ing model is made with a good investment material instead of stone. The hinge wires and tubing are adapted and held in position in exactly the same manner as in the other types of splints. As the main advantage of the silver appliance is greater rigidity with less bulk, the waxing is lighter; two thicknesses of 28 gauge casting wax usually are sufficient. The case is sprued (Fig. 206), invested, burned out, and cast as would be done for any large one-piece casting. The melted silver flows around the hinge wires and embeds them just as the acrylic resins or vulcanite does, except that the union is stronger in the case of silver. If the metal fails to cast completely around the wire or if the union is not quite perfect, the defect can easily be remedied by application of a little gold or silver solder. Pure silver

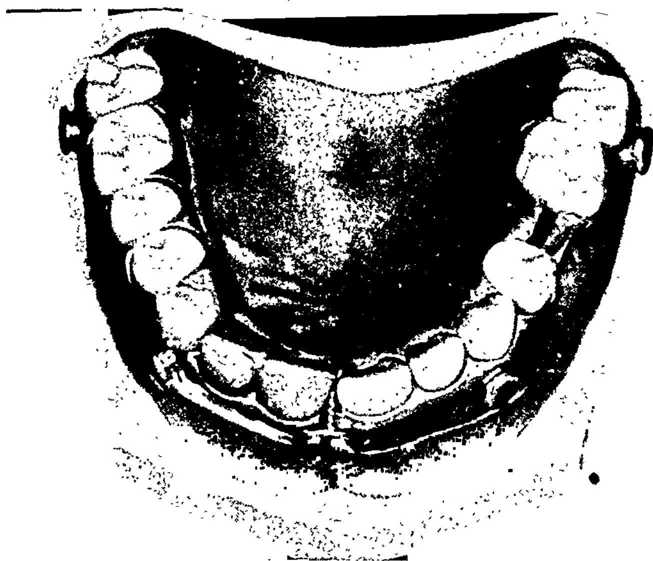


Fig. 207.—Cast-silver splint with undercut buttons for intra-oral or extra-oral traction; splint replaces two anterior teeth.

is not desirable for making splints as it is too soft and is not rigid enough. Ten per cent of copper added to the pure silver will overcome these objections and make a very suitable alloy for splints.

Providing for Traction

In some cases in which a sectional splint is applied it may be desirable to establish intermaxillary elastic traction as well. If this is true, small, flat, undercut buttons should be built into the splint at the time the waxing is done. Elastic bands can then be hooked around these buttons, the opposite ends being carried around the loops of intramaxillary, multiple loop wiring placed on the teeth of the opposite jaw. These buttons also can serve as attachments for extra-

Vulcanite Sectional Splint

The construction of vulcanite splint is identical in every detail to that of acrylic splint with the single exception that use of tinfoil is unnecessary if vulcanite is used.

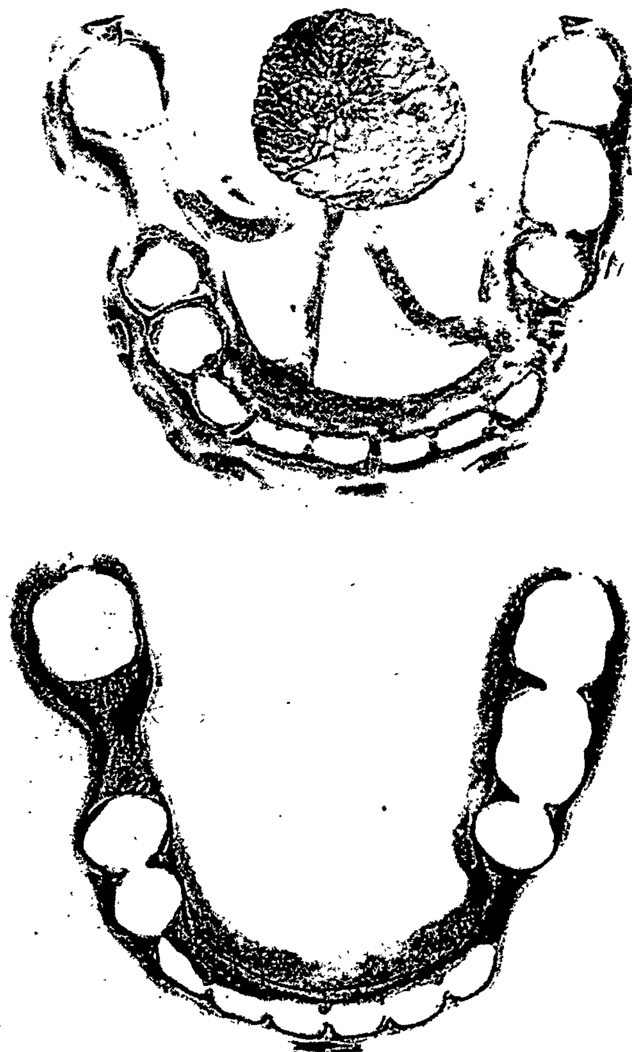


Fig. 206.—*Top,* cast-silver splint with button and sprues still attached; *bottom,* same splint polished and ready for cuts to be made through edentulous portions and the median line.

Silver Sectional Splint

If the appliance is to be made of silver, there are a few differences in the various steps of construction, but in general the process is the same. The silver splint is cast directly to the model, so that the work-

Modifications of Sectional Splint

Some variations of the sectional splint are even more simple than the basic three-piece design which has been described, and some, of

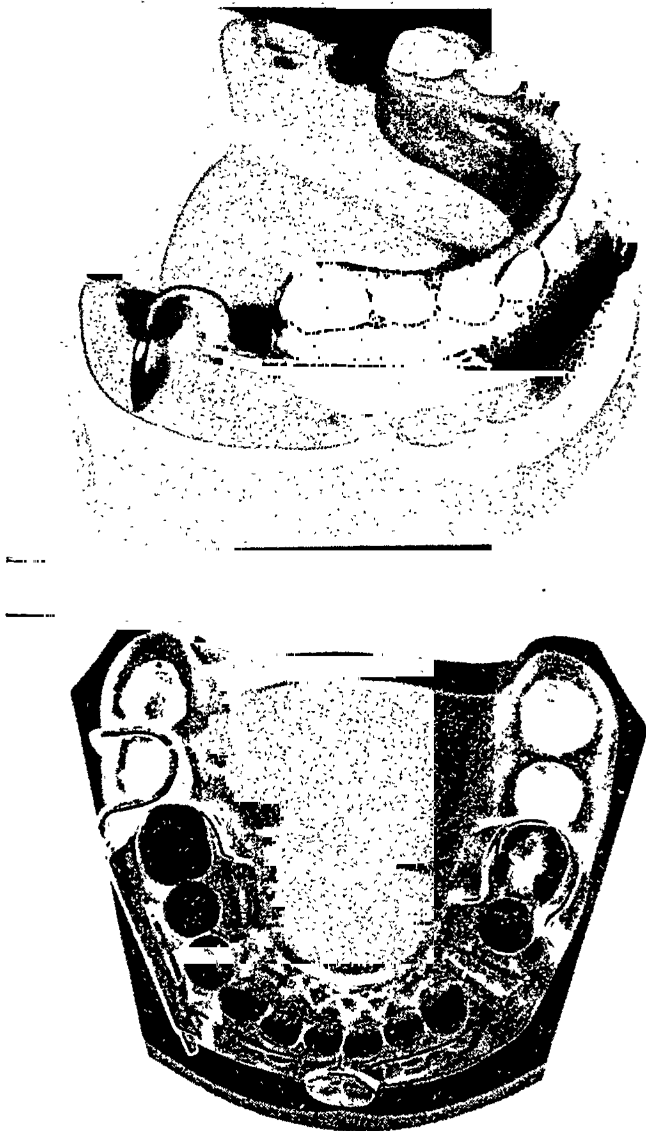


Fig. 210.—*Top* and *bottom*, sectional splint with intra-oral extension arm for control of posterior fragment in case of fracture of body of mandible, without teeth in the posterior fragment.

course, are much more complicated. The steps of construction, however, are essentially the same for any of them. The photographs accompanying the following short descriptions will illustrate a few of the more practical modifications.

oral traction. The buttons should be placed on the buccal surface of the splint, preferably one in each cuspid region and one in each third

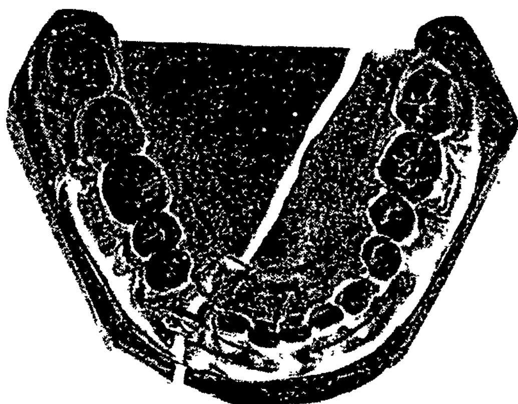


Fig. 208.—Clear acrylic splint, labial and lingual segments fixed in place by ligature wire through edentulous portion; no hinge connectors are used.

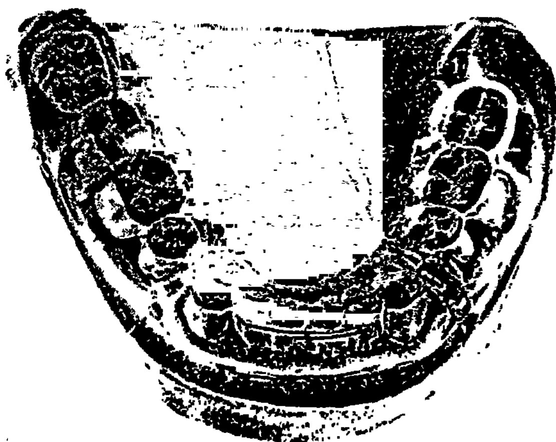


Fig. 209.—Splint, with one hinge connector, fixed in position with ligature wire passed through holes in edentulous portion.

molar region (Fig. 207). They are placed at these particular points because from them the elastic bands can be applied so as to produce traction in any desired direction.

the two segments together, thereby producing the necessary g
the teeth. This splint is limited in its application. It is most us
treatment of simple fractures or in cases of delayed union, w

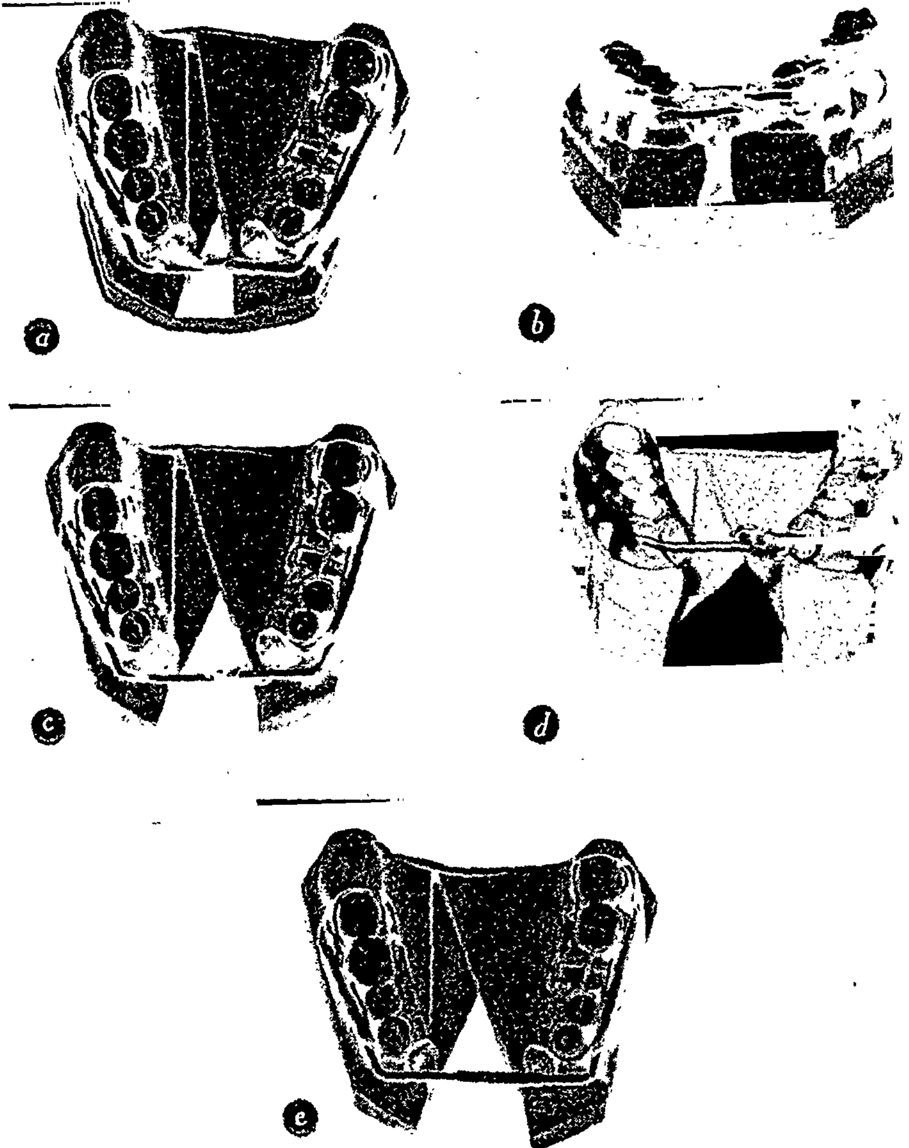


Fig. 213.—*a* and *b*, Sectional splints anchoring overlapping extension
for the application of elastic traction, to expand the arch in a case of co
of lateral segments; *c* and *d*, same case, expansion obtained; e, square t
over ends of square wire extension arms acts as a simple retainer.

retention and stabilization are desired during the final stage
consolidation.

Fig. 208 shows the sectional splint in its simplest form. It consists of a buccal segment and a lingual segment with no wire hinges or connectors. The lower right canine tooth, which was in the line of



Fig. 211.—Another view of appliance described in Fig. 210.



Fig. 212.—Cast-silver splint; labial section is divided at the edentulous portion, eliminating labial undercut button.

fracture, has been removed. The splint material in the region of the canine has been cut through mesiodistally, dividing the appliance into two pieces. Two parallel holes, drilled through the edentulous portion, permit a ligature wire to be passed which, when tightened, pulls

One of the most interesting modifications is the appliance represented in Fig. 213, *a, b, c, d.* In this case collapse of the fragments has taken place and a splint which will produce expansion is necessary. In reality there are two separate unilateral sectional splints, each

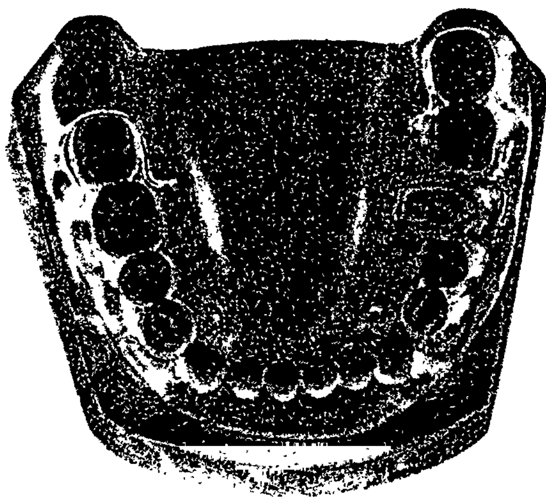




Fig. 215.—*Top* and *bottom,* acrylic splint with lingual section divided at the canine region so that the lingual portions can be moved medially to permit application of the splint.

having a tube into which intra-oral extension arms are inserted. Elastic bands placed around hooks on the ends of the arms produce the necessary traction for expansion and reestablishment of the former occlusal relation of the teeth.

Fig. 213, *e,* represents the same case. A section of square tubing

are drilled through each of the edentulous portions in the first premolar regions. Ligature wires passed through these holes, and tightened, secure the appliance to the teeth and hold it in position.

One of the most useful variations of the basic design is that shown in Figs. 210, 211. An intra-oral extension arm has been added for the purpose of controlling an edentulous posterior fragment which tends to an upward and outward displacement because of the muscles attached to it. Ligature wire around the undercut button at the median line normally will hold the splint in place, but additional retention

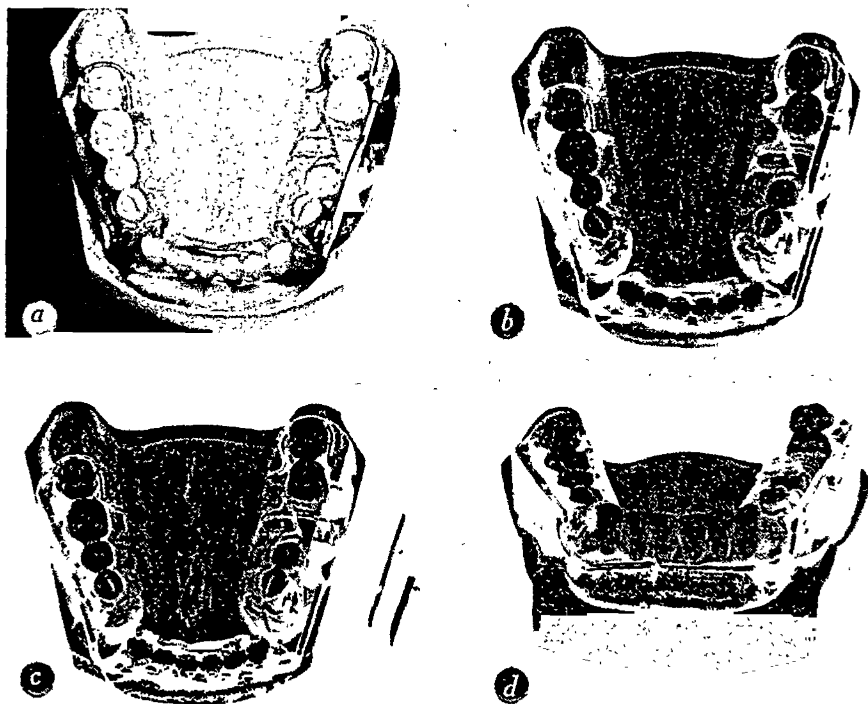


Fig. 214.—*a* through *d*, Another removable retention appliance which also is a stent and replaces the anterior teeth for esthetic reasons.

can be obtained by wires passed through holes in the edentulous portions, as shown in the illustrations.

In the splint represented in Fig. 212, the median line button has been eliminated. The usual mesiodistal cut is made through the left canine and premolar region. A second cut is made at right angles to the first one, but through the buccal segment only. This divides the buccal segment into two sections and allows the splint to be opened. Ligatures passed around the ends of the buccal sections and the lingual segment pull the parts into position and produce the necessary grip.

One of the most interesting modifications is the appliance represented in Fig. 213, *a, b, c, d.* In this case collapse of the fragments has taken place and a splint which will produce expansion is necessary. In reality there are two separate unilateral sectional splints, each



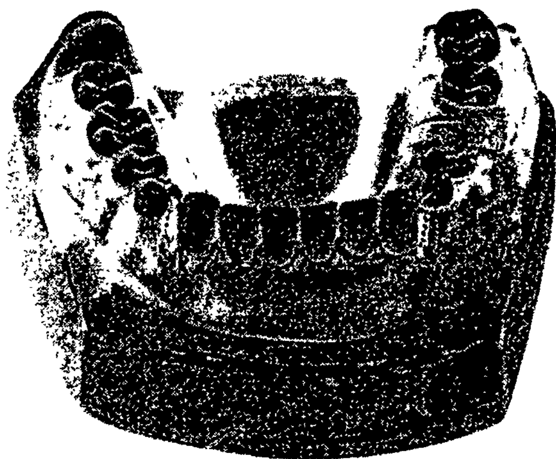


Fig. 215.—*Top* and *bottom,* acrylic splint with lingual section divided at the canine region so that the lingual portions can be moved medially to permit application of the splint.

having a tube into which intra-oral extension arms are inserted. Elastic bands placed around hooks on the ends of the arms produce the necessary traction for expansion and reestablishment of the former occlusal relation of the teeth.

Fig. 213, *e,* represents the same case. A section of square tubing

slips over the ends of the extension arms as a sleeve, thus maintaining the right and left fragments in the expanded position.

A more complicated splint, which serves the same purpose as that represented in Fig. 213, *e*, is the one illustrated in Fig. 214, *a, b, c, d.* The anterior segment, which maintains the expansion, consists of square wire to which porcelain teeth are attached by an acrylic base. The ends of the wire slip into the tubes on both unilateral splints, and the section is held in position, whereby it not only maintains the expansion, but restores lost teeth and tissue as well. This appliance has the added advantage of being removable in case restorative surgical procedures are indicated in the region of the symphysis.

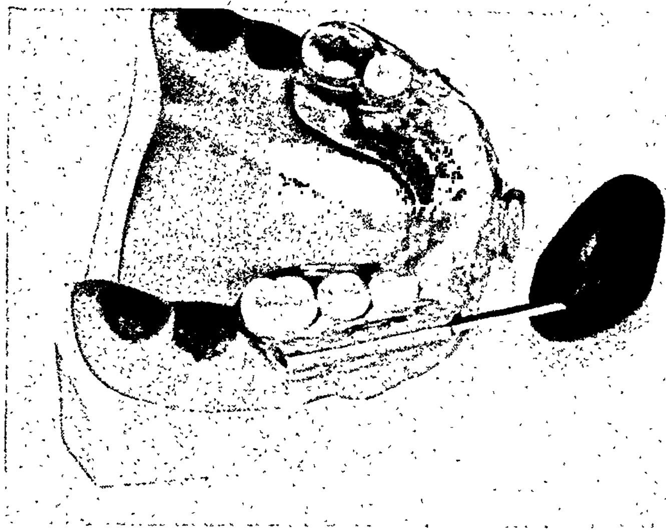


Fig. 216.—Splint with intra-oral extension arm and stent used in connection with certain dermal grafts.

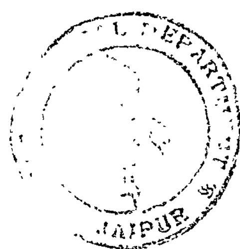
An acrylic splint for the same type of case, but which is made in a single piece without the use of tubes or arms, is pictured in Fig. 215. The cuts are made on the lingual section just mesial to the first premolar teeth. The portion from canine to canine is solid and is continuous with the buccal segment, the porcelain teeth being attached to this portion. When open, the two lingual sections swing inward, and when closed they are secured to the buccal segment by ligature wires which pass through holes in the splint, mesial to the first premolars.

Fig. 216 represents a stent of modeling compound supported by an intra-oral extension arm which is attached to the simple, three-piece, basic sectional splint. The use of a stent is of value in connection with certain intra-oral operations such as the making of dermal grafts, deepening of the buccal sulcus, or lowering of muscular attachments.

SECTION III

MAXILLOFACIAL PROSTHESIS

P. C. Lowery, D.D.S., M.S.



CHAPTER XIII

MAXILLOFACIAL PROSTHESIS

THE object of this section of the manual is to stimulate dentists of analytic and creative minds to further study of maxillofacial prosthesis.

Fundamentals of Prosthesis

Restoration of the function of mastication is the first aim in repair following intra-oral injuries. When injuries involve the tissues of the oral cavity, with loss of teeth and loss of bone, the surgeon's aim in treatment is to restore the mouth to such condition that the casualty will be able later to wear a satisfactory prosthetic appliance.

In débridement, all teeth possible should be saved, especially those of strategic value. Temporary prosthetic scaffolding, to assist in surgical reconstruction, should be built as early as is feasible, but it never should be worn if it retards healing or interferes with progress toward final surgical repair. These appliances serve as mechanical means of maintaining the hard and soft tissues in better alignment. They should be of simple construction, light weight, preferably removable, easily cleaned and, if possible, made to assist in mastication.

The *early* insertion of a prosthetic restoration following loss of anatomic structures may be the means of preventing a malattempt at rehabilitation. Casualties frequently form comfortable habits which are not conducive to satisfactory final prosthetic results.

Final prosthesis follows as soon as reconstructive surgery is completed and tissue tolerance will permit. The sooner function is brought to bear on edentulous areas the sooner the cortical bone will be formed. Regeneration of bone rather than resorption is thus brought about. Failure to employ early prosthetic restorations in accident cases is depriving the individual of a necessary health service.

Relationship between Surgeon and Dentist

In medicodental literature cooperation between the surgeon and the dental prosthetist is advocated. It should be scrupulously practiced. Both should strive for better interprofessional understanding.

Certain demands are made on surgeons, and certain requirements from a physical standpoint are necessary for mechanical retention of a dental prosthesis. The surgeon and dentist should have the same conception as to favorable mechanical retention, and both should strive to preserve and utilize it to the maximum.

DEFINITIONS

Prosthesis (or prothesis) is the replacement of an absent part by an artificial one. *Dental* prosthesis is the art of supplying missing teeth or parts of teeth by artificial substitutes. *Maxillofacial* prosthesis is defined as the treatment of, and repair following, injuries to the face and jaws, including artificial replacement of those parts. Maxillofacial prosthesis is of two main types: extra-oral and intra-oral.

Extra-oral prosthesis contributes greatly to the early psychologic rehabilitation of the casualty. The ultimate aim, however, is surgical reconstruction of the loss or deformity. Prosthetic appliances made of various materials used in dentistry accomplish this. These appliances may be worn before the wound has completely healed. In cases in which the condition of the casualty does not permit subjecting him to further surgical measures, these devices may be worn permanently. The skill and materials of the dentist are needed in the *construction of artificial appliances to supply parts lost by injuries* about the head, face, and jaws. Extra-oral prosthetic appliances considered here are those used as substitutes for appendages of the head or parts thereof.

Intra-oral prosthesis is dental maxillofacial prosthesis. Intra-oral prosthesis assists in restoration of the functions of mastication and deglutition and aids in speech. *Complete dentures* are a combination of dental and maxillofacial prosthesis because they supply a portion of the alveolar process lost through absorption or injury and help to maintain the vertical and horizontal dimensions of the face. *Partial removable dentures* may include replacement of lost portions of the jaws. *Obturators* and *velums* to close palatal perforations (acquired palatal defects) may be separate intra-oral appliances or may be attached to complete or removable partial dentures.

A combination consists of an extra-oral appliance attached to an intra-oral denture.

An *interim surgical prosthesis* should be constructed as scaffolding to assist in surgical reconstruction and to promote regeneration of tissues, in all instances wherein they do not retard healing or interfere with regeneration of tissues which have been subjected to sur-

gical measures or with final surgical operation. They also improve functional efficiency and appearance, with the object of rehabilitating the casualty both physiologically and psychologically.

Postsurgical prosthesis embodies the fundamental principles which govern complete and partial denture prosthesis as generally practiced. However, the methods and technical procedures must be dictated by the demands of the individual casualty.

INTRA-ORAL PROSTHESIS

Effect of Function

Function destroys, maintains, or restores the facial expression of those who wear artificial restorations, depending on the dentist's ability to place and maintain the stress area of the denture bases in advantageous relation to the traction of the muscles of mastication and expression.

Anatomic and Cosmetic Relations

Facial harmony is directly dependent on muscular tone, and this, in turn, is dependent on position of teeth and relation of adjacent anatomic structures. The origin and insertion of the muscles of mastication and expression must bear the same relation to each other after the dentures have been inserted that they had before the injury; perhaps, even, the relation of these structures can be improved. The outline form and position of the denture base within the denture space, as well as the alignment of the teeth, direct the tension and support of the muscles about the mouth and are the means by which tension and support are secured and maintained. Thus cosmetics depend on mechanics (Figs. 217, 218, 219).

When the three muscular forces—of the external layer of the masseter, the internal pterygoid, and the temporal muscles—are coordinated, their combined force is in a vertical direction in the neighborhood of the second premolar, first molar, and second molar regions. This direction, according to observation, is in a direct line with the fibers of the deep portion of the masseter muscle and the vertical fibers of the temporal muscles. To maintain facial contour and balance, the resistance tension should be placed where nature intended it to be placed (Fig. 217), which is the position illustrated. Thus muscle balance and physiologic function restore and maintain the facial expression of the individual.

Fig. 219 represents an excessive loss of maxillary alveolar structure. It shows disuse atrophy of the muscles caused by prolonged

habits of anterior mastication, with infrequency of swallowing. A persistent effort to clear the throat was manifested by a peculiar cough

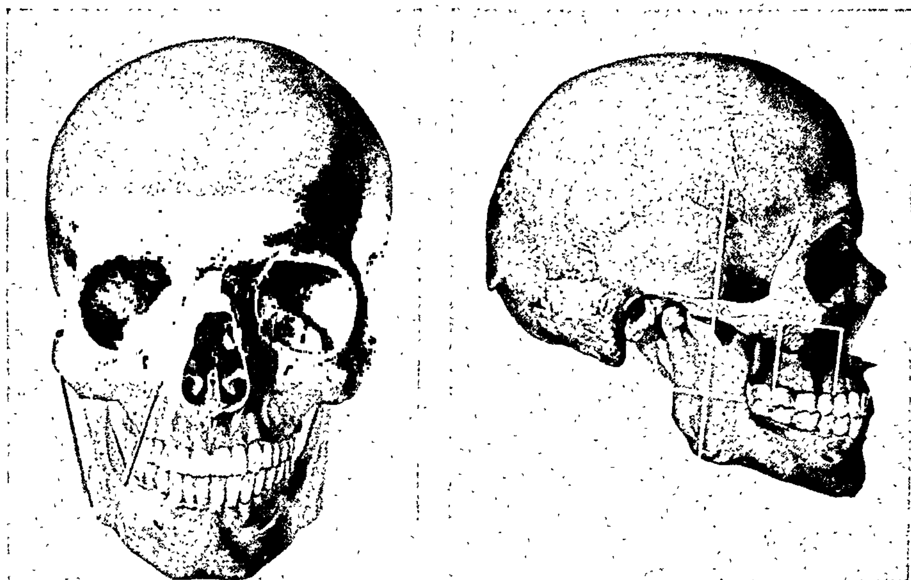


Fig. 217.—*Left,* lines of traction of masseter and internal pterygoid muscles; *right,* direction of stress on denture as determined by line of traction of temporal and superficial masseter muscles.



Fig. 218.—*Left,* distortion of facial contour caused by excessive loss of alveolar process; *right,* facial expression restored by complete artificial dentures (Teeth, Health, and Appearance).

with lips closed. Correction of the mandibular position by means of complete artificial dentures replacing the lost structures, together



Fig. 219.—*Left column,* the loss of facial expression caused by disuse atrophy; *right column,* restoration of facial expression following reconstruction of artificial dentures (Lowery).

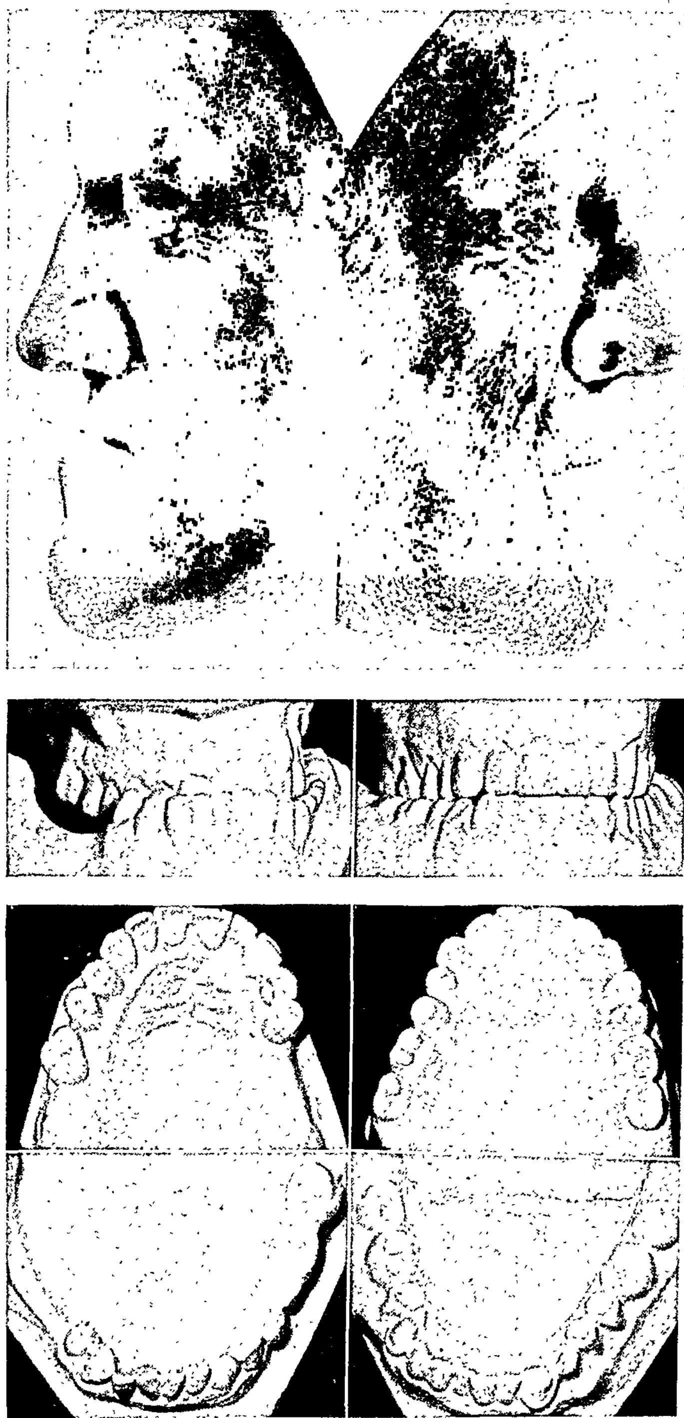


Fig. 220.—*Left column,* before and, *right column,* after restoration of a lost vertical dimension of 16 mm.; this automatically restored the horizontal dimension, correcting a right mandibular deflection (Jamieson).

with proper alignment of the artificial teeth, restored the muscles to physiologic function.

Swallowing and Restoration

Swallowing usually is an unconscious, involuntary act. The casualty suffering anatomic losses should be impressed with the value of swallowing with effort, so that it will become habitual. In this manner not only are the appliances seated under definite stress but the



Fig. 221.—*Left,* distortion of facial contour caused by excessive loss of mandibular structure and consequent collapse of tissue; *right,* function restored the facial contour following reestablishment of mandibular position by means of a partial denture which also artificially replaced the lost structures; the restoration was an aluminum-core vulcanite partial denture with wrought-clasp retention on the two remaining teeth (the lower left second and third molars) in an effort to prevent absorption caused by weight of denture; the aluminum core was cast in two parts and jointed by malleting and burnishing to a union. A more recent restoration would have a hollow acrylic resin base or an acrylic base made with a stainless steel alloy core.

function of the salivary glands is improved. Proper deglutition drains and stimulates the tissues of the oral cavity, and aids in draining and ventilating the nasal and pharyngeal sinuses. It also aerates the middle ear through the eustachian tube by equalizing any differential in air pressure which may exist.

Full instructions should be given on prophylactic care, on how and how not to use the dentures in mastication, and on the types of food which can be more easily masticated during the early stages of healing.

Some other results of restorations are represented in Fig. 220.

Prosthetic Materials

The two methods of restoration, plastic and prosthetic, were developed independently in the course of the war of 1914–1918. Dentists created special prosthetic appliances to supply the sudden demand. Their choice of material was inadequate. As their ability to devise increased there was a decrease in the demand caused by the

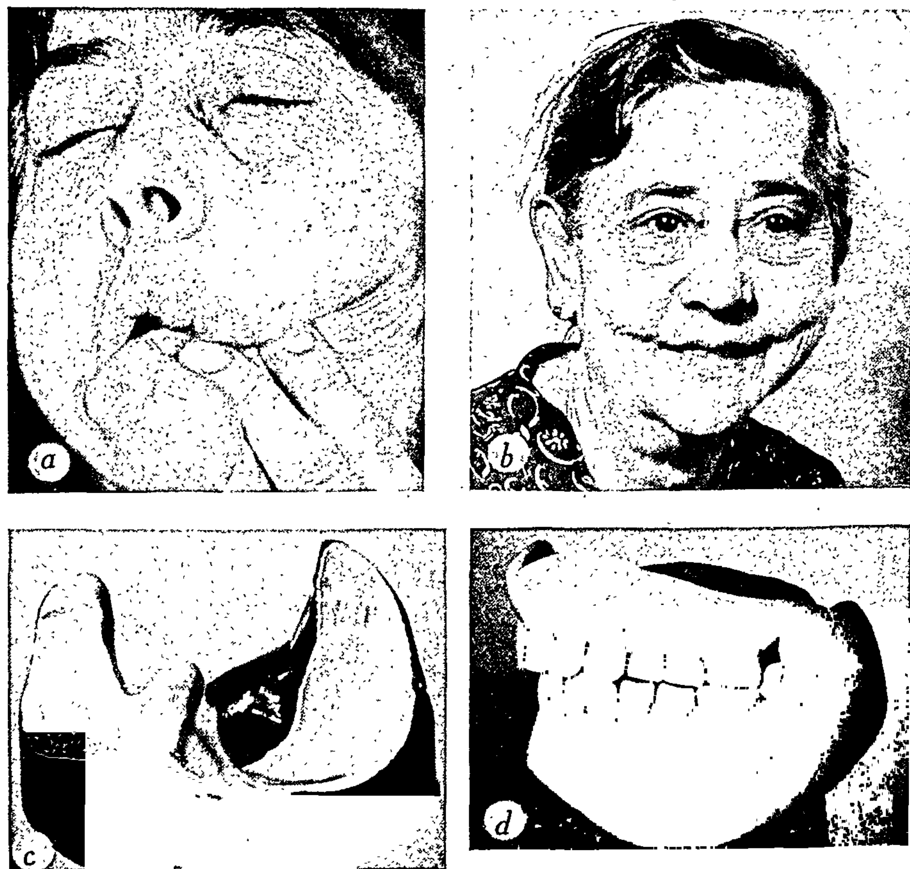


Fig. 222.—*a, b, c, d,* Edentulous patient with entire left mandible (from symphysis) missing; treatment was by construction of complete upper and lower dentures, with extension of left side of lower denture to occlude at tuberosity with upper denture, and sufficient fulness on that side for stability. A hollow, acrylic resin bulb on the left side would decrease the weight of the lower denture (Fitz-Gibbon).

advancement in plastic surgery. Today the fundamental principles which were used in former prosthesis remain; there is a better selection of materials with which to build and the promise of still more natural and cosmetic prosthetic materials in the near future.

Many new materials have been introduced into dentistry. Some have become indispensable; for example, the hydrocolloidal impres-

sion material, plastic impression waxes, zinc oxide impression paste, prevulcanized liquid rubber, stainless steel alloys, and acrylic resin denture base material, especially methyl-methacrylate.



Fig. 223.—Profile and full-face views of patient before and after restoring of facial lines. *Left column,* loss of expression caused by disuse following surgical resection of body of mandible from a point slightly anterior to the angle on the right side to the angle on the left side; *right column,* appearance following insertion of lower denture; the restoration was accomplished with a complete lower denture of vulcanite with an aluminum core; the impression was made to conform to the conception of its needs by carving. A superior denture would result today from an impression of plastic soft wax and fabrication of a lightweight, hollow, acrylic resin denture base with acrylic teeth.

Acrylic Resin.—Acrylic resin denture base materials increase the efficiency of maxillofacial prosth
material weight encourages heal

decreased and appearance improved when acrylic resin teeth are used. The smoothness of the union between acrylic teeth and acrylic base materials tends to increase comfort of tongue and oral tissue, and particularly it aids speech. The restoration may be made hollow by the use of a core in forming it. This will decrease further the weight of the appliance. In the past, aluminum cores were used with vulcanite. The choice today is in favor either of a stainless steel alloy



Fig. 224.—*Top,* intra-oral view; wound involving the antrum; *bottom,* replacement; partial denture of gold and acrylic resin (Kingery).

core used with acrylic resin or of a hollow acrylic resin base used without a core. How weight would be decreased today is pointed out in Figs. 221, 222, 223.

Palatal Defects

These are either congenital or acquired (disease or accident). Civilian dentistry deals mostly with congenital palatal defects; military dentistry, with acquired ones. However, examples of various congenital-cleft-palate appliances will aid the military dentist in fa-

miliarizing himself with the fundamentals and principles involved in this type of replacement.



Fig. 225.—*Top,* the wound that is represented involved the nasal cavity; *bottom,* replacement by partial vulcanite denture (Whitman).

The acquired defect is referred to as a "perforation" in contrast to the congenital cleft. The congenital cleft is in the median line, while the acquired perforation may occur in any area of the palate. Most

acquired defects can be restored surgically, but the remaining few require a prosthetic restoration. Such prosthetic appliances are of two types, the obturator and the artificial velum with variations.

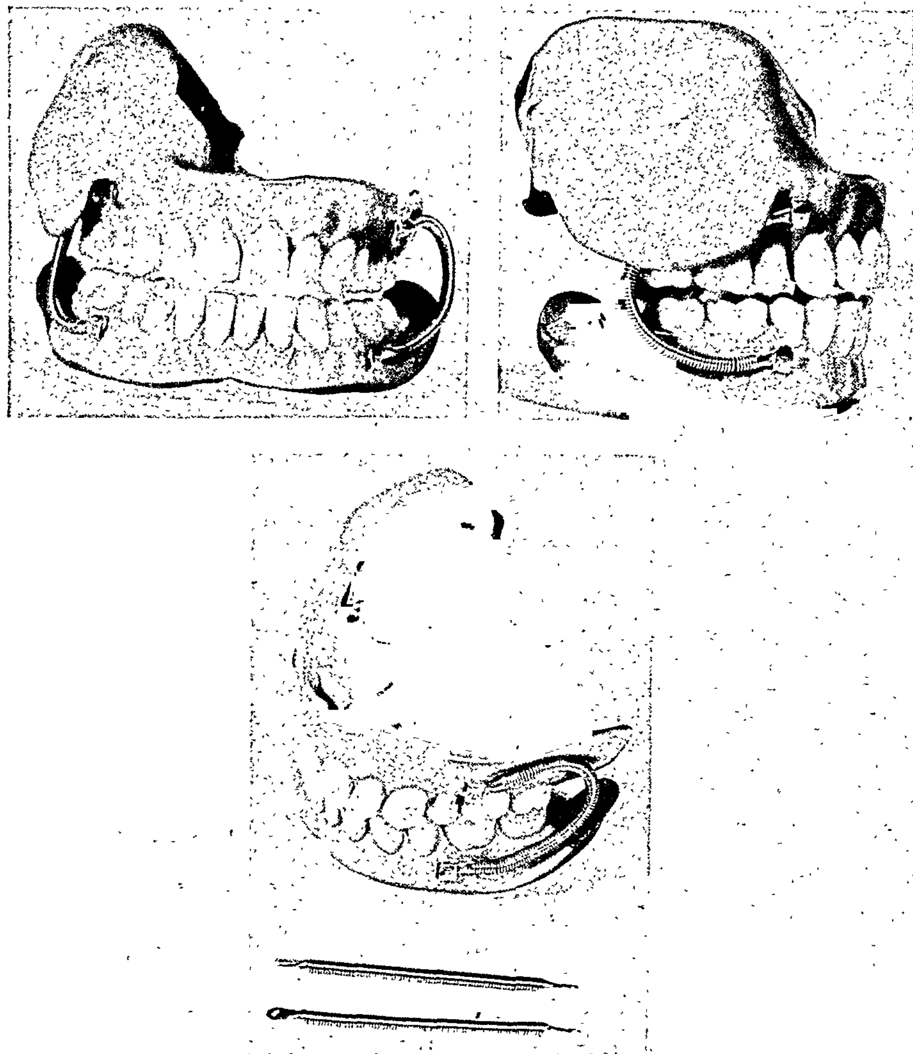


Fig. 226.—Prosthetic reconstruction following large loss of right palatal, maxillary, and malar structures; construction was with vulcanite and a metal spring (Boos). With favorable relation of maxillary and mandibular ridges, this appliance now could be constructed with a hollow-bulb acrylic resin base, so light that, with balanced occlusion of the teeth, the spring could be eliminated.

Construction of bulb of hollow acrylic resin is as follows: Process in two parts; then join together, observing all principles of processing methyl-methacrylate. If rebasing is anticipated, a stainless-steel alloy core can be inserted. However, with careful technic rebasing of bulb type is possible.

Early restoration of function for the casualty is most important; this requires that temporary appliances be constructed and used until such time as permanent treatment can be initiated. With an imperfect

palate there is interference with both speech and mastication. An appliance worn early will prevent the abnormal muscular coordination

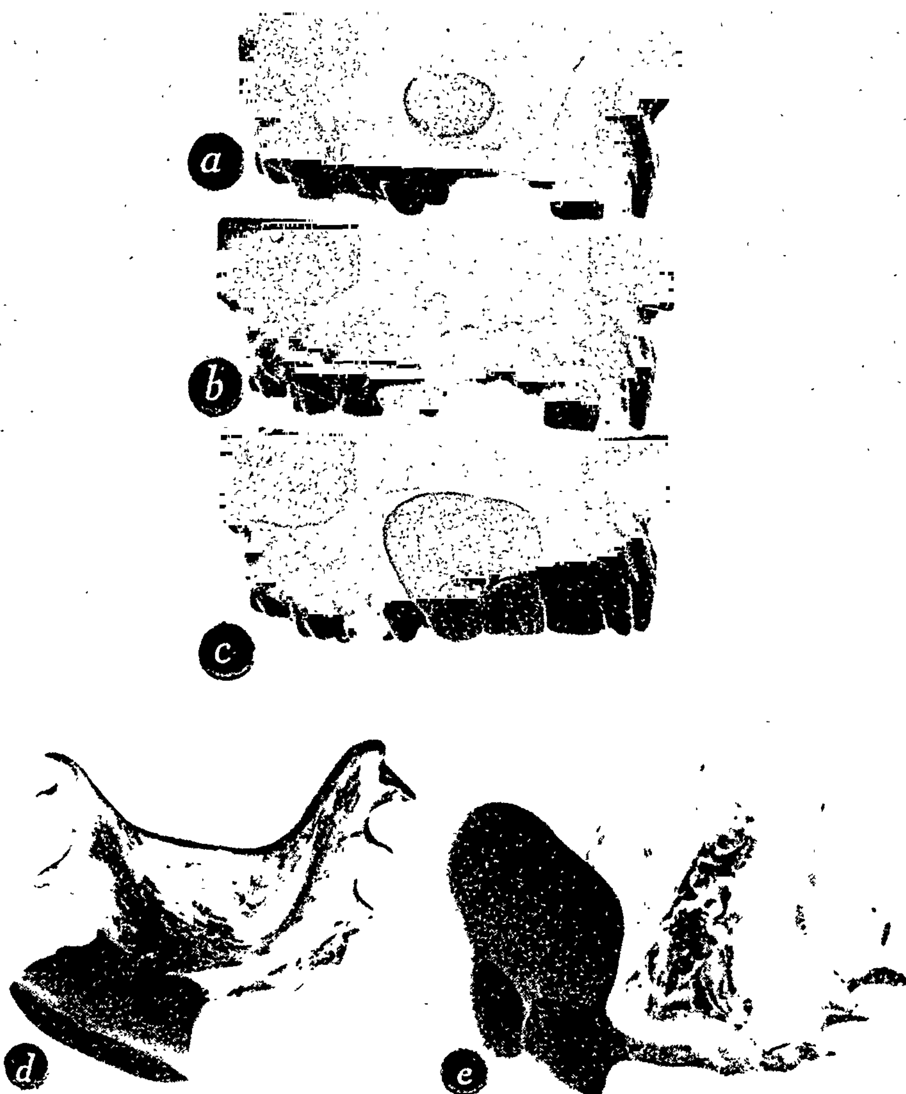


Fig. 227.—In the case represented there was loss and regeneration of tissue following excision of a cyst. Intermittent pressure on the appliance in the course of mastication caused stimulation, which in turn brought about regeneration of tissue. Both mechanical and biologic principles should be utilized in repair.

a, Representation of condition three months after operation and prior to prosthesis; *b*, one year following insertion of prosthetic appliance; *c*, removable acrylic resin appliance in position; *d*, palatal view of appliance; *e*, labial view of appliance (Donaldson).

which results from an attempt to perfect speech under abnormal conditions and also will prevent food from passing into the nares during deglutition.

The choice of design and material for use in a prosthetic applianc to correct an imperfect palate depends on knowledge of the norma function of the muscles and tissues surrounding the region of the los and on knowledge of the physical properties of the various materials



Fig. 228.—The wound that is represented entered the antrum. To prevent leakage of air under the denture, a gold ferrule was inserted through the denture base. As regeneration progressed, the gold ferrule and denture base were decreased.

Some appliances relevant to the material of the preceding paragraphs are illustrated in Figs. 224–228 inclusive.

Morale of Patient

Negative psychologic states, such as worry and self-pity, must be dispelled and replaced with positive qualities before the casualty can be successfully rehabilitated. A temporary prosthesis which maintains relation of the jaws and muscular tone prior to final surgical measures and final prosthesis aids in maintaining the morale of the individual.

Study of Defects

Information can be obtained by thorough intra-oral and extra-oral examination, also from records, such as photographs, intra-oral and extra-oral and profile roentgenograms, facial masks, articulated study models, and a single cast of anterior teeth in their normal relation, and so on. These are the usual immediate denture service records.

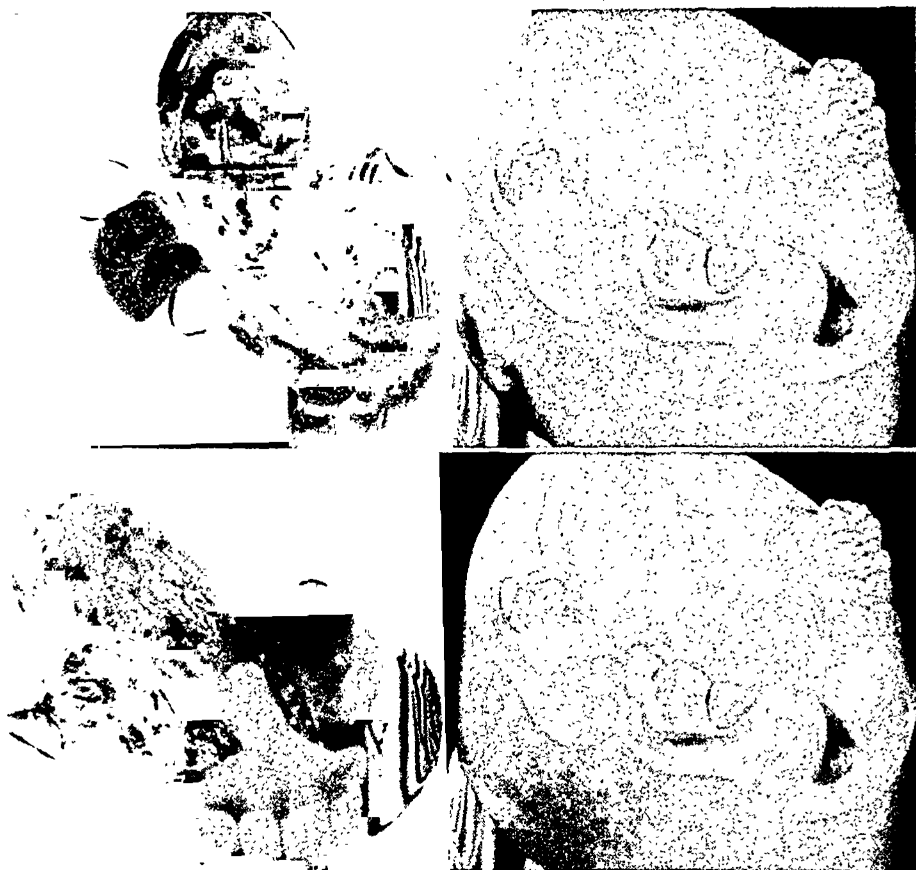


Fig. 229.—Different views of a model and of an appliance for congenital cleft palate. Construction of the appliance; methyl-methacrylate with hinge. The objection raised to the hinge type of restoration is that it allows escape of air, which affects the function of speech (Nelson). A similar design can be constructed without a hinge by attaching a hollow bulb.

These factors determine the anatomic details which are to be eliminated or maintained, corrected or improved.

Special Considerations

The importance of simplicity of design and accuracy of technical execution should be stressed. Building without a plan is, at best, a pastime. At worst, it is a costly indulgence.



Fig. 230.—*a,* Profile without appliance; *b,* profile with appliance; *c,* full face with appliance.

Past history of surgical procedures: Operation on palate and lip in childhood resulting in a good surgical result but marked velar insufficiency.

Treatment: Premolars protected with cast bases for overlays. Slight dissection of lip for flexibility. Appliance constructed with overlays for contour of lip, cosmetic considerations, and speech (Fitz-Gibbon). This is an exceptional result. When space for anterior teeth is restricted, overlays fabricated with acrylic teeth may be made very thin and still have strength and give good appearance.

The wrought clasp is first choice for mechanical retention of temporary appliances. It is resilient, placing but slight strain on the abut-





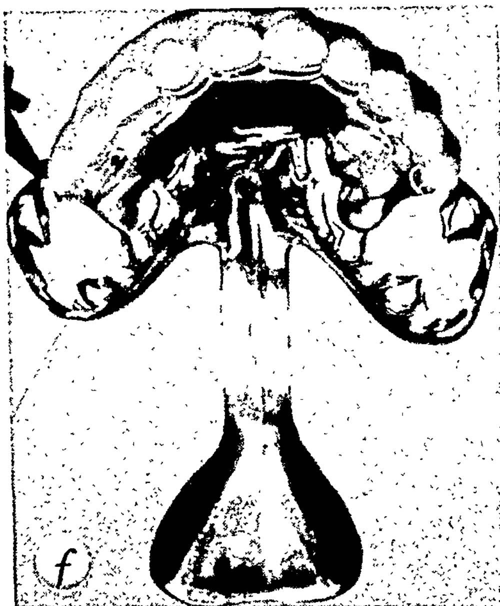


Fig. 230.—*d*, Maxillary model showing velar insufficiency; e, intra-oral view of appliance showing position of bulb; *f*, full view of appliance (Fitz-Gibbon).

ment teeth; it is easy to construct and to adjust and entails few complications when rebasing is necessary.

It is often necessary to remove some teeth preceding construction of a final prosthesis. Prior to the extraction of two or three teeth in a series, the following rules should be observed: Secure an impression,





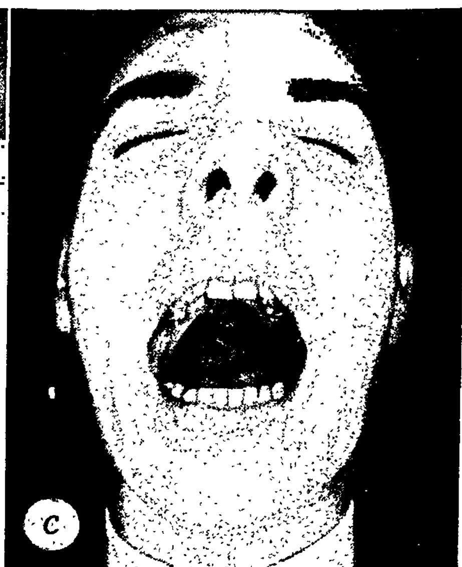


Fig. 231.—*a,* Maxillary model; *b,* intra-oral view of maxillary condition; *c,* appliance in position.

Past history of surgical procedures: One operation performed before patient was two years of age. Result, fair; extreme velar insufficiency and mutilation of posterior pillars.

Treatment: Speech appliance constructed, correcting velar insufficiency. When "setback" procedure for lengthening palate is impracticable, this type of prosthesis is indicated (Fitz-Gibbon).

pour a cast, make a splint of acrylic resin (with or without teeth) or of base plate with compound for an occlusal rest and, following the extractions, place it over the edentulous region.

The object of the splint is threefold: (1) It predetermines and preserves the outline form of the ridges and muscular attachments and prevents muscular collapse with its attendant change in the temporomandibular articulation. (2) It acts as a surgical dressing to prevent

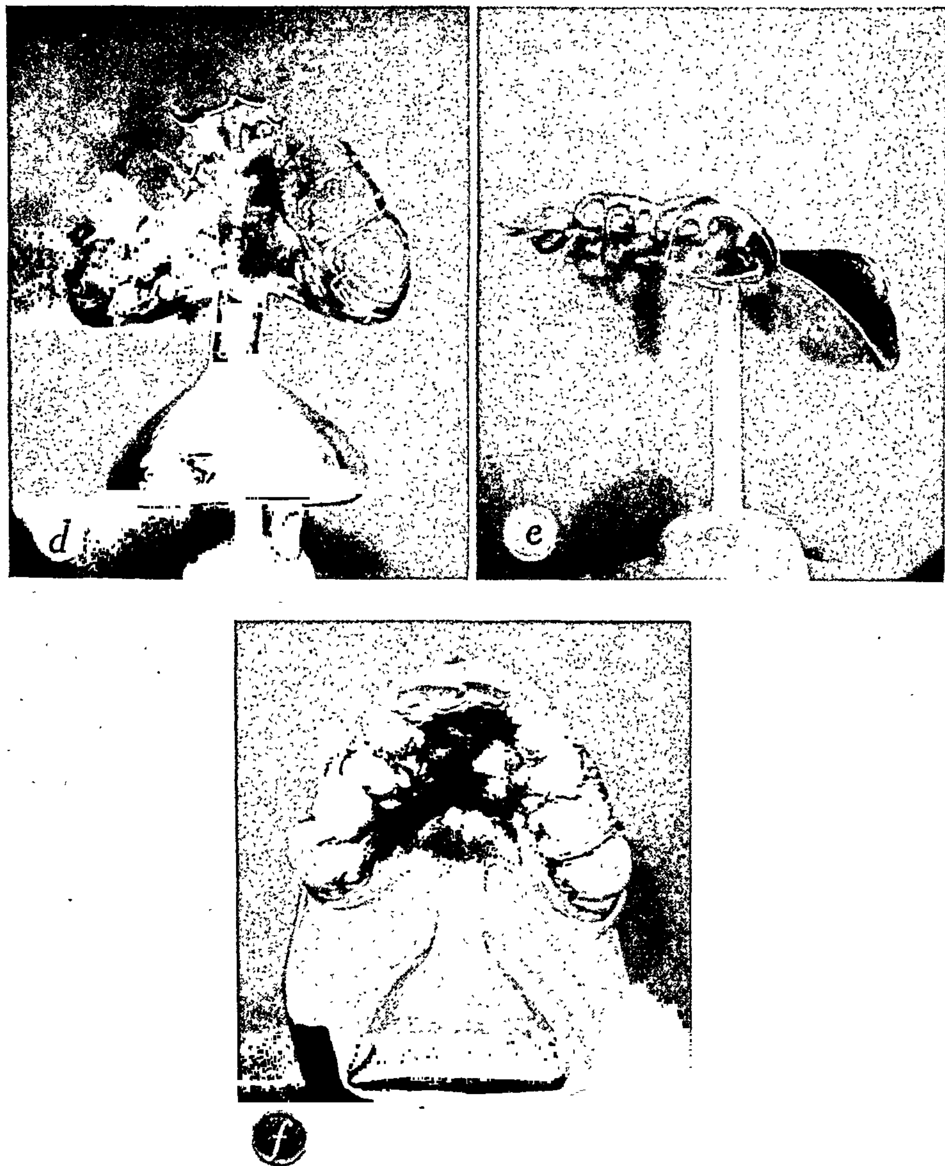


Fig. 231.—*d*, Lingual view of appliance; *e*, lateral view of appliance; *f*, appliance on model (Fitz-Gibbon).

reinfection. (3) It has all the advantages of an immediate denture in case of hemorrhage or postoperative discomfort.

Still some more appliances for intra-oral prosthesis are illustrated in Figs. 229–235 inclusive.



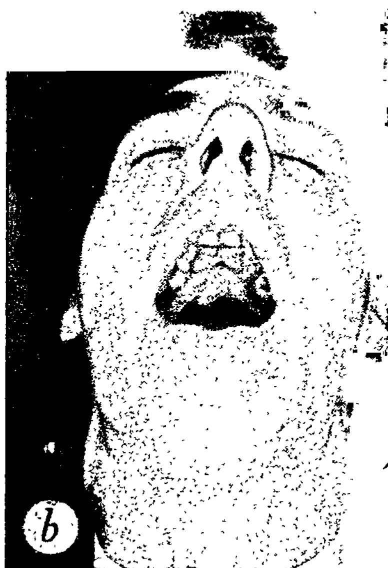




Fig. 231.—*a*, Maxillary model; *b*, intra-oral view of maxillary condition; *c*, appliance in position.

Past history of surgical procedures: One operation performed before patient was two years of age. Result, fair; extreme velar insufficiency and mutilation of posterior pillars.

Treatment: Speech appliance constructed, correcting velar insufficiency. When "setback" procedure for lengthening palate is impracticable, this type of prosthesis is indicated (Fitz-Gibbon).

pour a cast, make a splint of acrylic resin (with or without teeth) or of base plate with compound for an occlusal rest and, following the extractions, place it over the edentulous region.

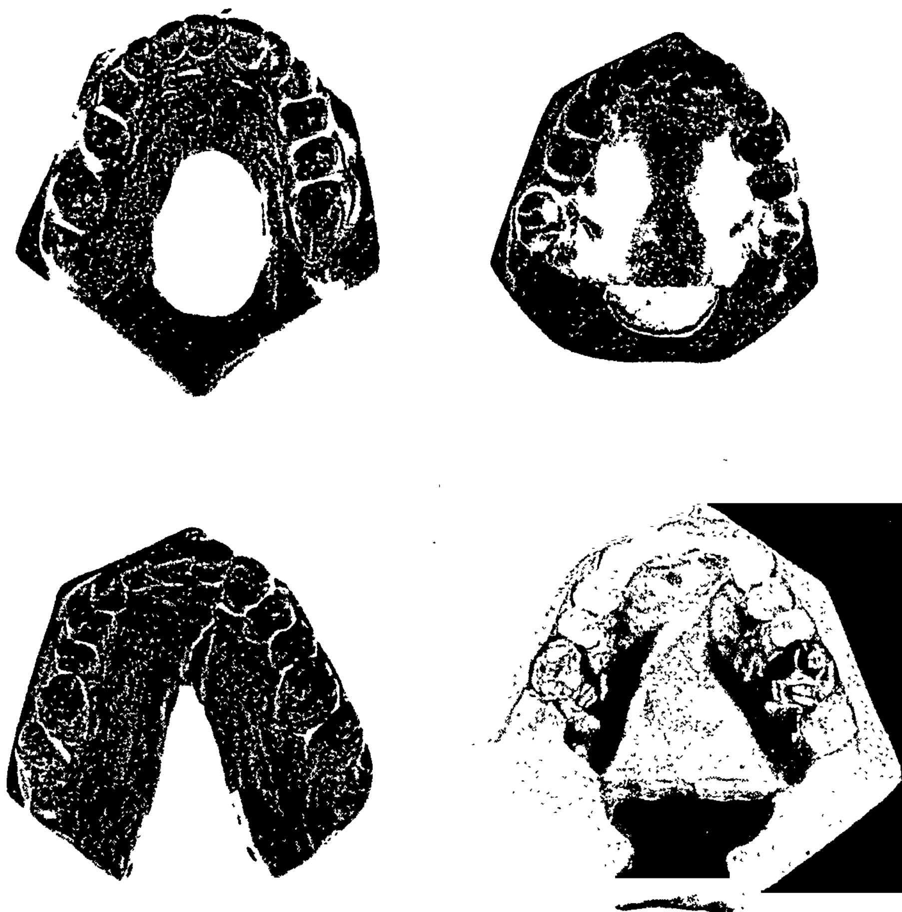


Fig. 233.—*Left column,* two types of cleft palate; *right column,* appliance for each is a partial denture with soft velum replacing palatal and missing soft structures (Whitman).

Individuals with cleft palates seem readily to tolerate, and adjust themselves to, this type of restoration. Soft velum vulcanite, when worn in the mouth for a short period, becomes very unsanitary due to its absorptive properties. Those who do the type of work represented here are hopeful of a more sanitary resilient material which will contribute to the more extensive use of this type of restoration.



Fig. 232.—*a*, Maxillary model; *b*, profile without restoration; *c*, occluding models; *d*, lingual view of appliance; *e*, superior view of appliance; *f*, full face without restoration; *g*, appliance in position; *h*, side view with appliance; *i*, full face, appliance in position.

Past history of surgical procedures: Two operations on lip; two operations on palate.

Treatment: Speech appliance constructed, restoring facial palatal contours, functional occlusion, and speech mechanism (bulb) (Fitz-Gibbon).



Fig. 235.—Considerable loss of anterior mandibular hard and soft structure. Restored with gold and vulcanite partial denture. A more recent appliance would utilize an acrylic bulb to decrease the weight.

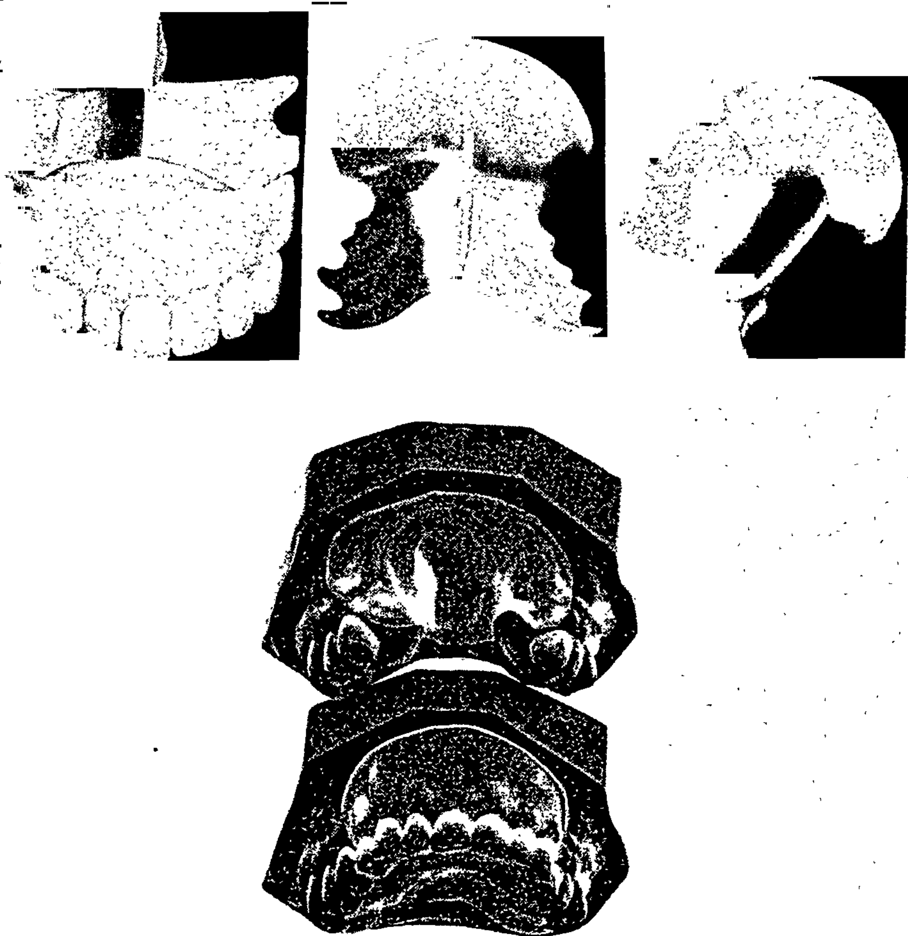


Fig. 234.—Various views representing considerable loss of intra-oral hard and soft tissue. Former restoration was constructed of hard and soft velum vulcanite; unsanitary and very heavy. Reconstructed of methyl-methacrylate, hollow bulb in anterior portion by processing in two sections and joining. The pseudo-vomer replacement aids greatly in speech, and the light weight adds to comfort and efficiency.

be least noticeable. Healing is of primary importance. The appliance must not be so heavy as to retard healing, nor may it irritate the tissues and delay final plastic operations. The chief function of the

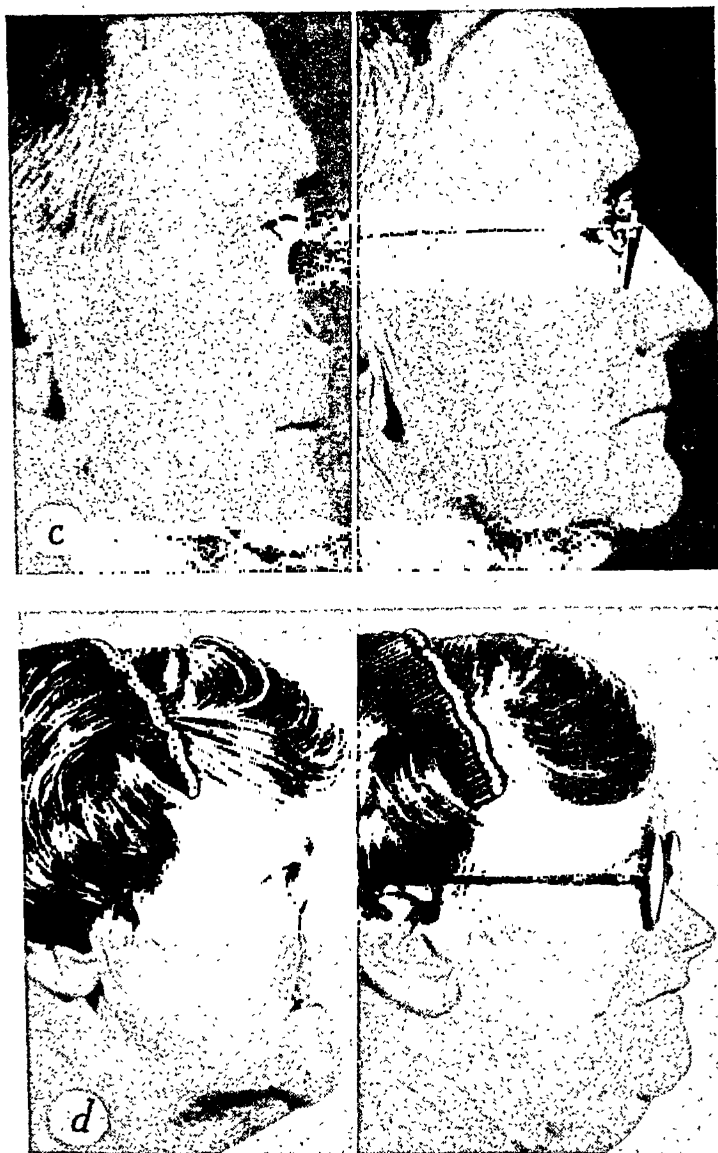


Fig. 236.—c, Loss (left) and prosthetic replacement (right) of entire nose; d, loss (left) and prosthetic replacement (right) of entire nose and upper lip (Bulbulian). These replacements may be the ultimate result, depending on surgical and prosthetic judgment.

temporary appliance during this period is to improve appearance and maintain the morale of the casualty, while acting as a scaffolding for plastic surgery.

An ear, a nose, a cheek wholly or partially destroyed, an eye, or

EXTRA-ORAL PROSTHESIS

Maxillofacial prosthesis supplying appendages of the head or parts thereof will be considered. The surgeon, from the first surgical inter-

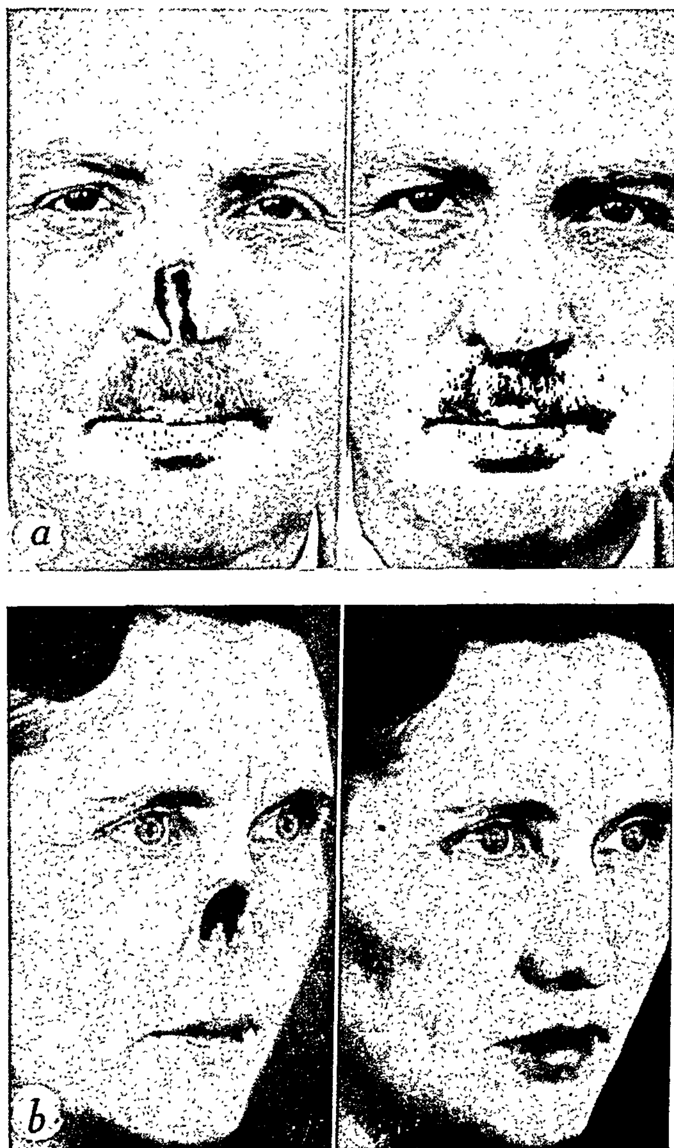


Fig. 236.—*a*, Loss (left) and prosthetic replacement (right) of tip of nose; *b*, loss (left) and prosthetic replacement (right) of major portion of nose (Bulbulian). These examples are of interim surgical prosthesis to be worn until replacement by autoplasty.

ference, bearing in mind the need for subsequent prosthetic restoration, can aid by providing areas of retention around the wound and can provide finishing lines in the shadows of the face where they will

of which impression is to be made, to confine flow of impression material.

4. Apply hydrocolloidal impression material; stiffen with wire mattress; chill with ice water through metal coil; reinforce with plaster. Do not apply hydrocolloid too hot; it burns the skin as does wax. Chill the tissues of the face by applying ice

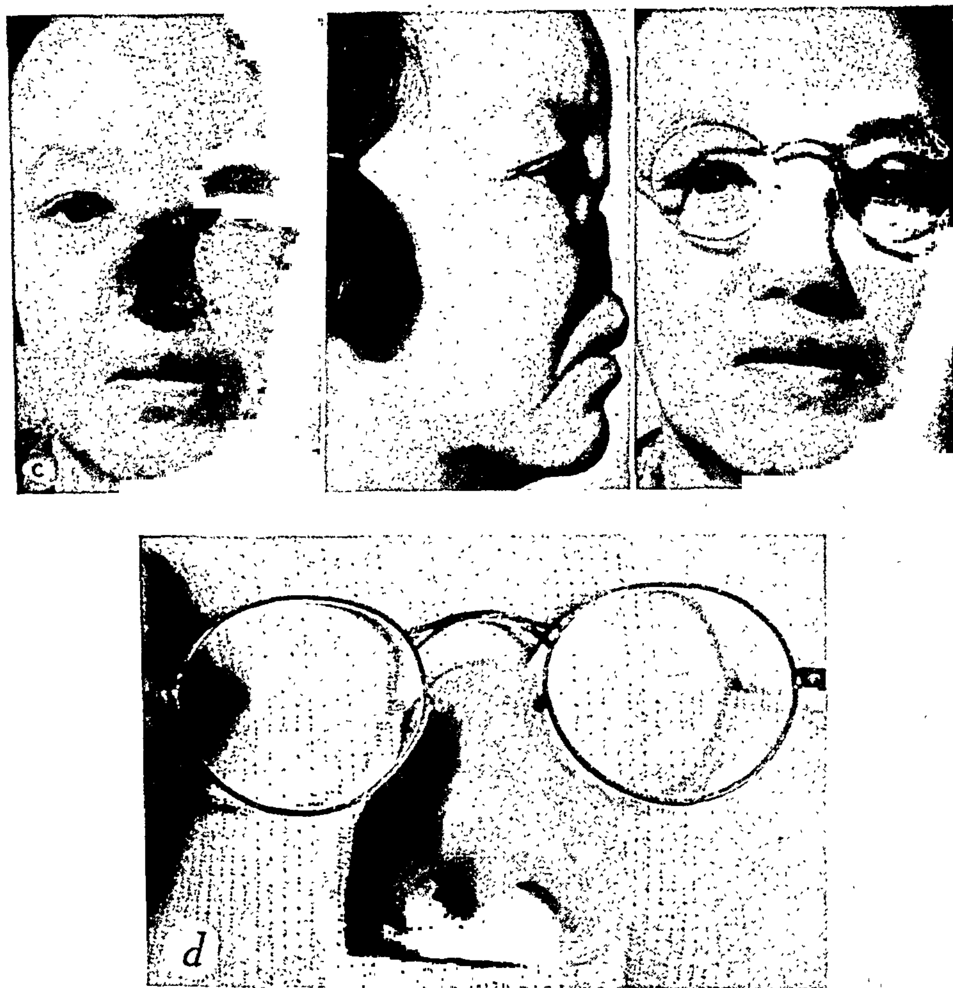


Fig. 237.—Prosthetic replacement of nose. *c* and *d*, Replacement constructed of acrylin resin (Munson, F. T., and Heron, D. F.: Am. J. Surg., Aug., 1941).

when heat is not well tolerated. Thoroughly dry the surface of the face; this will prevent discomfort when impression material is applied.

Impression of Specific Region.—Obtain an impression of the region to be restored and the adjacent tissues, including the face or the side of the head. This may be a direct impression taken with a hydrocolloidal material, plaster of paris, or soluble plaster. Place

parts of the head can be supplied by artificial appliances made, pre-
erably of acrylic resin or prevulcanized liquid rubber.



Fig. 237.—Prosthetic replacement of nose. *a* and *b*, Replacement constructed of latex compound (Munson, F. T., and Heron, D. F.: Am. J. Surg., Aug., 1941).

Technic of Prosthesis for Nose and Ear

The making of a facial mask is an essential part of the technic of construction of an extra-oral prosthesis.

Facial Mask Impression: Material and Method

1. Measuring wire, same as that used for making profile.
2. Cut out cardboard to fit portion to be walled off.
3. Carding wax or modeling clay placed at right angles to surface

of which impression is to be made, to confine flow of impression material.

4. Apply hydrocolloidal impression material; stiffen with wire mattress; chill with ice water through metal coil; reinforce with plaster. Do not apply hydrocolloid too hot; it burns the skin as does wax. Chill the tissues of the face by applying ice

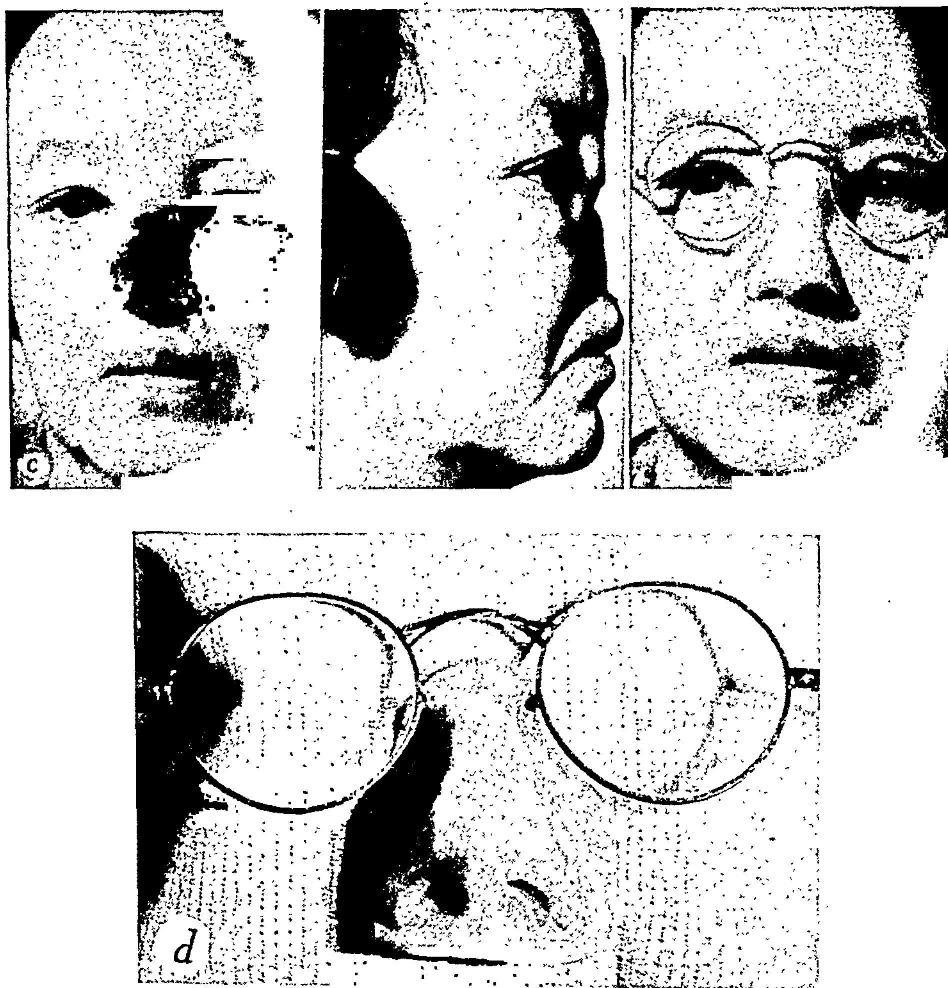


Fig. 237.—Prosthetic replacement of nose. c and *d*, Replacement constructed of acrylin resin (Munson, F. T., and Heron, D. F.: Am. J. Surg., Aug., 1941).

when heat is not well tolerated. Thoroughly dry the surface of the face; this will prevent discomfort when impression material is applied.

Impression of Specific Region.—Obtain an impression of the region to be restored and the adjacent tissues, including the face or the side of the head. This may be a direct impression taken with a hydrocolloidal material, plaster of paris, or soluble plaster. Place

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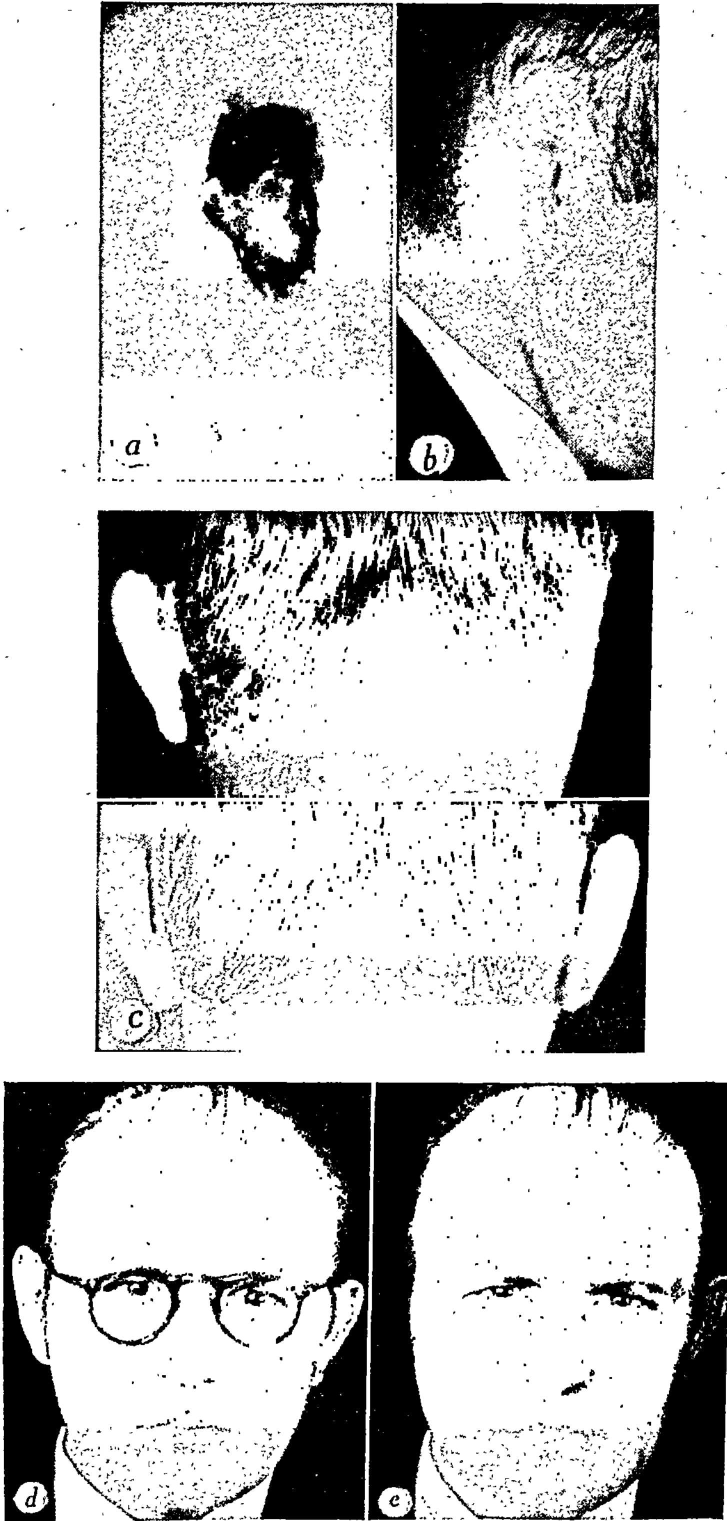


Fig. 238.—*a* and *b*, Site of defect; *c*, posterior view before and after prosthesis; *d*, appearance of patient wearing prosthetic ear constructed of latex compound; *e*, full front view showing loss of right auricle (Bellinger).

gauze, cotton, or soybean wool, and cover with cellophane applied with surgical glue to prevent impression material flowing in unnecessary areas.



Fig. 239.—*Left,* appearance of patient showing loss of entire right auricle; *right,* appearance of patient wearing prosthetic ear constructed from a latex compound (Bulbulian).

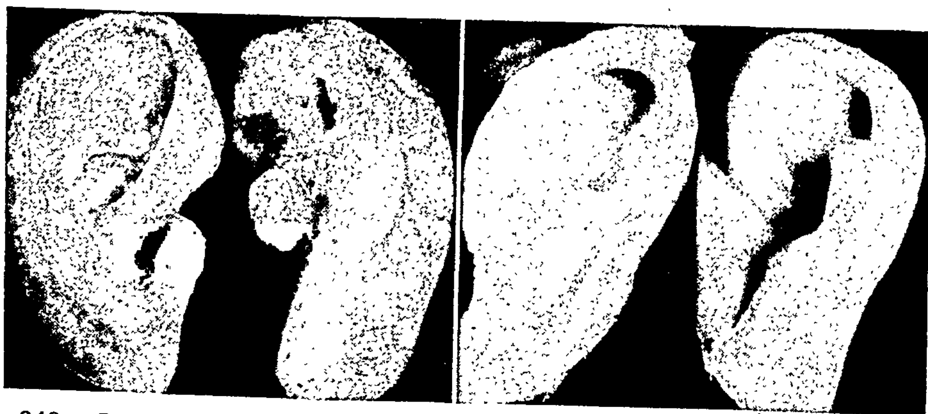


Fig. 240.—*Left,* two views of an artificial ear constructed of prevulcanized, liquid rubber; *right,* two views of an artificial ear constructed of gelatin.

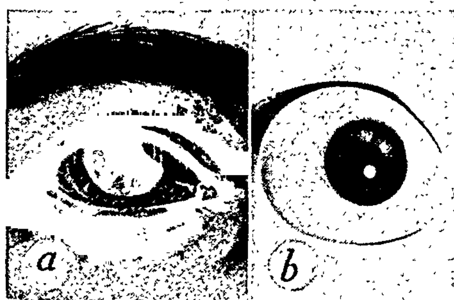
Impression Materials

1. Hydrocolloid has good elastic properties. It may cause distortion of soft tissues where undercuts are present.
2. Plaster of paris, if extreme accuracy of soft tissues is desired.
3. Soluble plaster.
4. Plastic soft wax.

Casts and Moulages. Plaster, Stone, and Wax Base Materials

Direct-Indirect Method

1. Obtain good front and profile photographs. If one ear is to be replaced, mirror photographs of the remaining ear should be made.
2. Duplicate the master cast for a working model.
3. Carve the missing member in wax on the working model. This calls for sculptural ability. If a nose is to be replaced, an impression of a similar nose is frequently of assistance in



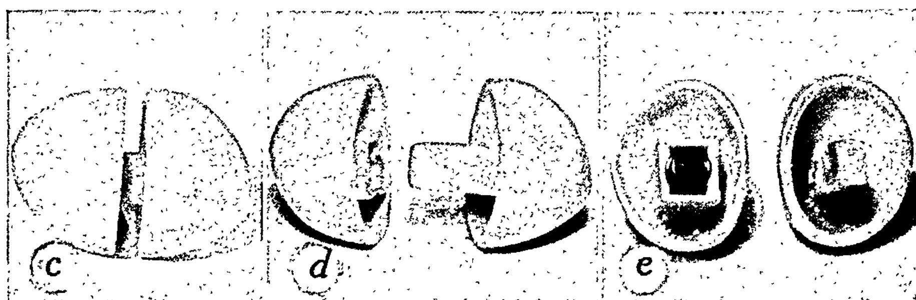


Fig. 241.—A split prosthetic appliance with spring tension will serve to maintain the form of the orbital cavity for reception of a prosthetic artificial eye. *a,* Natural eye; *b,* artificial glass eye; *c* and *d,* views of an acrylic resin appliance in two pieces; *e,* spring in place to create and maintain tension on tissue. This principle may be used in various modified forms; a bulb in one piece may be used as a stent for surgical aid.

sculpturing the new one. A mask of the face or side of the head aids in indirect carving. All finished borders must be planned so as not to appear conspicuous.

4. The size and shape must reproduce the missing member as faithfully as possible. Proper consideration must be given to the texture as well as to the color of the surrounding skin. Color of skin changes with the seasons.
5. Duplication of wax patterns is similar to the same step in complete denture service.

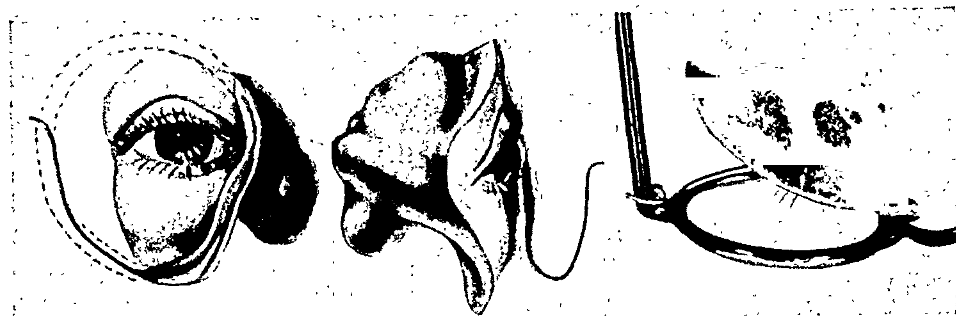
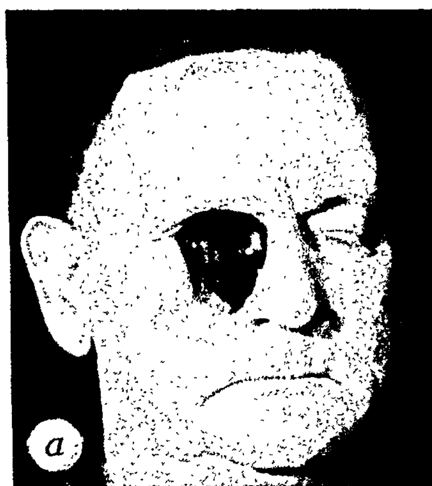
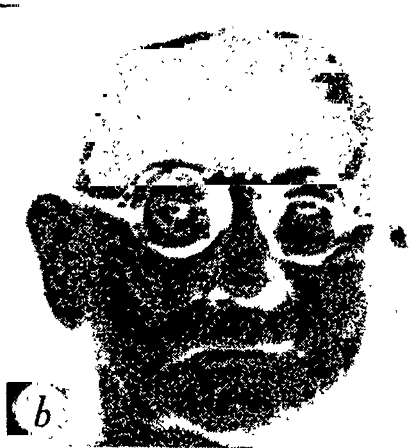


Fig. 242.—Three views of an appliance. The method of attachment and degree of replacement are dependent on the extent of the loss (Kazanjian).





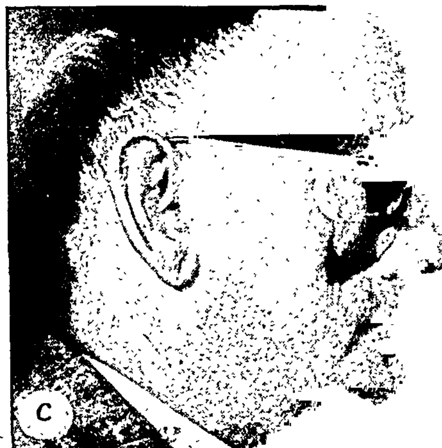


Fig. 243.—*a*, Appearance of patient without appliance attached to eyeglass frames; *b* and *c*, patient wearing the appliance (Kazanjian).

Materials

1. Prevulcanized rubber. This material shrinks; consequently the wax pattern must be slightly larger.

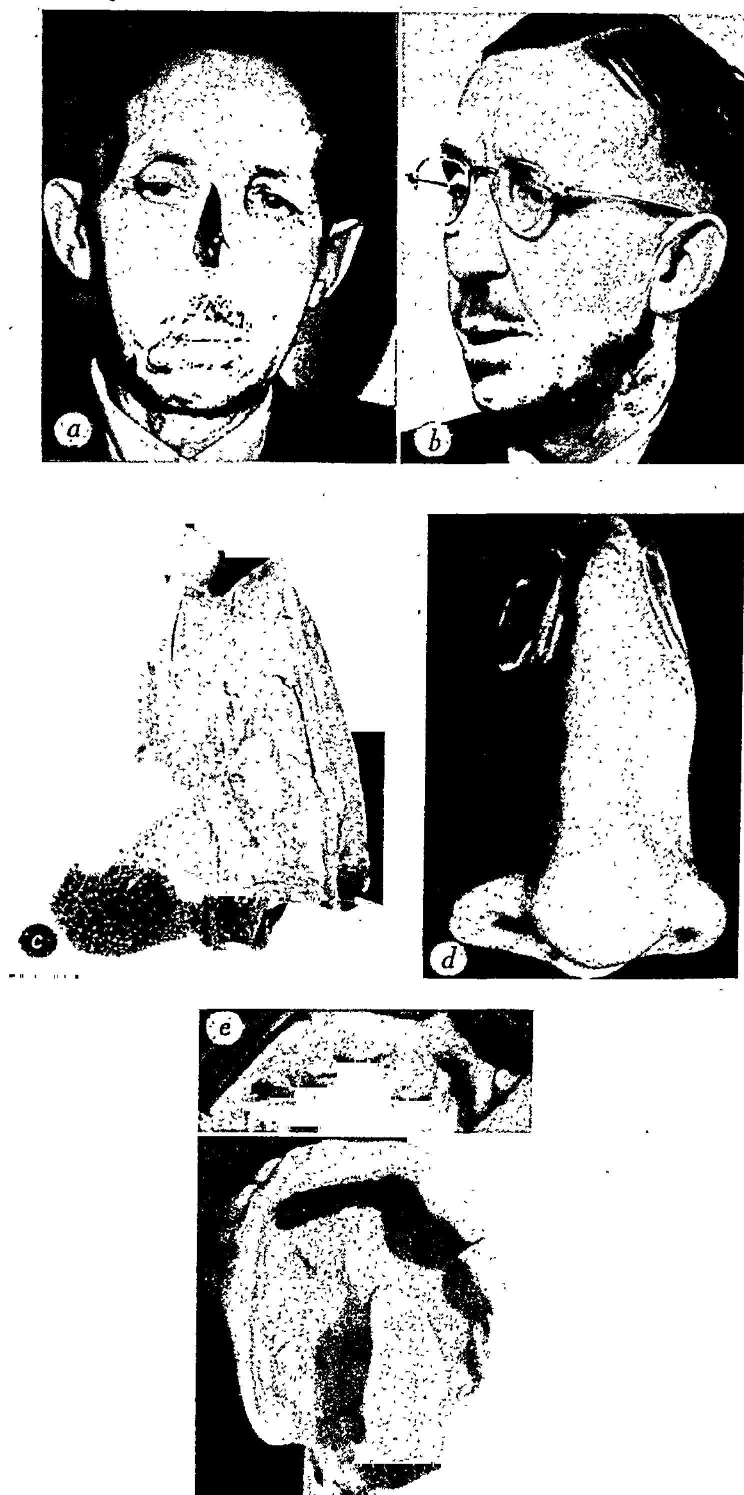


Fig. 244.—*a*, Extra-oral view; *b*, three-quarter view with all appliances in position; *c*, lateral view of nose showing method of retention; *d*, full view of artificial nose restoration; *e*, intra-oral view and superior view of speech appliance.

2. Methyl-methacrylate. This does not shrink appreciably. The methods of processing are directed by the manufacturers of the various materials.

Application and Retention

1. Ear: Take advantage of the ear canal, of any remaining portions of the ear, and of any lined undercuts which the surgeon may provide.
2. Nose: Same as above. Spectacle frames made of acrylic resin, without the rims or metal; lenses of unbreakable glass. The attachment of the prosthesis to the spectacle frame must result in proper balance.

Examples of Prosthetic Appliances for Lost Noses and Ears. See Figs. 236–240 inclusive.

Prosthesis for Orbit

Orbital losses may be of the soft structures within the orbital cavity, or large bones and soft tissue of the orbital region may be destroyed.

Violent removal of the eye, such as may occur in war, often results in constriction of the tissues about the orbital cavity. To alleviate this, a temporary replacement may be used to prevent strictures and to maintain, as much as possible, the proper contour. The appliance should be placed as early as possible. It could be fabricated of acrylic resin material. However, if strictures already have developed within the orbital cavity, the artificial replacement would be smaller, would be halved, and would contain an inner spring, thus breaking down the strictures until the final plastic surgical repair.

Illustrations relevant to prosthesis of the orbit are Figs. 241, 242, 243.

COMBINATION PROSTHESIS

These combinations are as varied as the individual casualty. There is a demand for this type of replacement for temporary use in rehabilitating the casualty both cosmetically and psychologically. Far too little attention is being given to the importance of such restorations.

Condition of oral cavity: Complete destruction of soft palate and a portion of hard palate. Vomer, turbinates, triangular cartilage, median walls of antrums, and parts of the sphenoid missing. Ethmoidal, frontal, and maxillary sinuses exposed. Remaining teeth extremely mobile and suppuration around them.

Treatment and prognosis: Removal of all teeth. Trimming of process. Anterior maxillary flap closure (surgical) for sup[illegible] speech appliance, denture, and nose improve[illegible] Gibbon).



Fig. 245.

Following the final surgical procedure, or in cases in which autoplasty is not advisable, the prosthodontist should make every effort to replace the missing structures with a permanent prosthetic appliance. In this effort creative ability is of primary importance.

Examples are illustrated in Figs. 244, 245.

CONCLUDING REMARKS

Suitable appliances for various regions have been illustrated in the effort to emphasize the importance of the prosthodontist's responsibility in rehabilitating the war casualty. This section of the manual should serve to stimulate the dentist to create a satisfactory appliance for the specific need of the individual. It is in no way intended to curb his creative or mechanical ingenuity.

The organization of a central unit for general and dental prosthesis for the concluding work of rehabilitating the war casualty is highly commended. This unit would have the following advantages:

1. Isolation from the general hospital environment.
2. Improved efficiency and economy.
3. Ability of the dentist to pool his skill with the plastic and maxillofacial surgeon, the sculptor, the artist, the engineer, the oculist, the technician, the speech instructor, and the voice instructor.
4. The merging of interprofessional principles.

Fig. 245.—*a*, Edentulous patient with loss of entire nose and upper lip; *b* and *c*, patient wearing prosthetic appliance; *d* and *e*, two views of combination prosthetic appliance; material is vulcanite; methyl-methacrylate would be a cosmetic improvement (Boos).

SECTION IV

ANESTHETIC TECHNICS

Leigh C. Fairbank, Brigadier General, Medical Department, U. S. Army
Roy A. Stout, Lieutenant Colonel, Dental Corps, U. S. Army
Frederick P. Haugen, M.D.

CHAPTER XIV

LOCAL ANESTHESIA*

THE majority of injuries of the face and jaws can be successfully treated under local anesthesia. The condition of the patient, the field of operation, the nature and severity of the injuries, also the complications encountered, will influence selection of the anesthetic agent. Paresthesia may be present as a result of trauma to main nerve branches or of fractures involving the bony canals or foramina through which nerve fibers are transmitted; only limited supplemental infiltrative anesthesia may be necessary to assure a painless operative field in these cases. Surgical procedures about the face and jaws require complete understanding of the application of infiltrative, topical, and regional block anesthesia, including thorough knowledge of the anatomy of the parts.

Strict observance of the most exacting technic is essential when local anesthetic agents are employed for maxillofacial surgery. The slightest technical omission or the slightest contamination occurring in the course of administering local anesthetic agents may result in the introduction of infecting micro-organisms or extension of existing infection to the deeper tissues or even to the intracranial structures.

Procaine hydrochloride is considered the most satisfactory local anesthetic agent and is the one most extensively used in the Army. Its power of rapidly inhibiting sensory impulses produces profound anesthesia and, by the addition of a vasoconstricting substance, *epinephrine,* its value is further enhanced and anesthesia is maintained over a longer period of time. Solutions of procaine are used in various strengths, from 0.5 to 15 per cent, depending on the type of application and the tissues involved. Topical anesthesia requires a solution of the higher strength; infiltrative anesthesia is usually successful when the 0.5 or 1 per cent solution is used; regional blocking of the nerve trunks about the face and jaws is most successful when the 2 per cent solution is used. Six minims of epinephrine (1:1000), added to 30 cc. of a 2 per cent solution of procaine, is a most effective preparation for oral anesthesia. A 1 per cent solution of procaine, with epinephrine (1:1000), 6 minims of the epinephrine solution to 100 cc.

* By Brigadier General Fairbank and Lieutenant Colonel Stout.

of the procaine solution, has been found to be sufficient for plastic surgery of the head and neck. The character of the wound, the structures involved and the condition of the patient will largely determine the procedure.

INFILTRATIVE ANESTHESIA

Many patients who have wounds of the face can be properly anesthetized by means of infiltration with a solution of *procaine* and *epinephrine*. The 1 per cent solution is more desirable for subcutaneous injections about the face than a weaker solution because, when the stronger solution is employed, smaller amounts can be used, thus avoiding distortion of the structures. Some wounds preclude this procedure because of the deep structures involved or because of existing infection. Blocking of the nerve trunks or branches at some distance from the operative field is then more desirable. Wounds involving the nose, orbit, or ear often require combinations of both infiltrative and deep block anesthesia. Likewise, combination of infiltration and block anesthesia will be necessary for surgical procedures about the jaws. Wounds of the tongue and floor of the mouth require both infiltration and block anesthesia. Anesthesia of the entire tongue and floor of the mouth can be secured by injecting each lingual nerve in the vicinity of the internal oblique line and alveolar process of the mandible and by infiltration of the base of the tongue, intra-orally or extra-orally. For the extra-oral method, the needle is inserted in the median line, between the lower border of the mandible and the hyoid bone, and the point of the needle is directed to the base of the tongue. The solution is deposited so as to infiltrate the entire width and base of the tongue while the needle is partially withdrawn and reinserted.

TOPICAL ANESTHESIA

In dealing with wounds of the nasal cavities, the anesthetic agent can be applied directly to the tissues by use of tampons or cotton applicators. Topical application of the anesthetic agent to the lateral and septal surfaces, in the vicinity of the entrance of their respective nerve supply, will anesthetize the intranasal structures. Solution of *cocaine* is most satisfactory for topical application. However, a 10 to 15 per cent solution of *procaine,* with *epinephrine,* usually will be satisfactory, provided the saturated applicators are maintained in contact with the tissues and the measures are repeated two or three times at intervals of five minutes. Topical application of the anesthetic agent will produce satisfactory intranasal block if properly done.

REGIONAL ANESTHESIA

Regional anesthesia, requiring deep blocking of the maxillary and mandibular divisions of the trigeminal nerve, often is indicated for operations on the face or jaw, or both. Satisfactory anesthesia throughout the distribution of the main divisions and peripheral branches of these divisions can be obtained by depositing the solution in the vicinity of the foramina from which they emerge from the skull. Aspiration should be employed prior to deposition of the solution, whenever the needle is inserted deeply. Blood drawn into the syringe by slightly withdrawing the plunger would indicate that the point of the needle was resting in a vessel and location of the needle point should be altered before the injection. The amount of solution necessary will vary. However, 2 per cent solution has been recommended for regional anesthesia and usually 2 to 6 cc. suffice.

Intra-oral Technic

An intra-oral route to the maxillary division of the trigeminal nerve is by way of the maxillary tuberosity. The needle is inserted in the mucobuccal fold, in the region of the upper second or third molar tooth, and the point is directed inward, upward, and backward to the maxillary tuberosity at an angle of about 45 degrees with the occlusal surface of the molar teeth. The angle is then increased to keep the beveled point in contact with the posterior surface of the maxilla and the needle is advanced approximately 15 mm. further. The anesthetic solution now can be deposited in the vicinity of the maxillary nerve, where it crosses the pterygopalatine fossa as it passes from the foramen rotundum to the orifice of the infra-orbital canal (Fig. 246).

To follow an intra-oral route to the maxillary division of the trigeminal nerve, by way of the pterygopalatine canal, the needle is inserted through the greater palatine foramen and is advanced through the pterygopalatine canal to the pterygopalatine fossa, in the vicinity of the foramen rotundum, where the solution is deposited. A needle marker should be set and carefully observed to prevent entrance into the cranial cavity (Fig. 247). A small piece of rubber on the shaft of the needle may be placed at the desired location to indicate the depth of insertion.

The mandibular division of the trigeminal nerve can be anesthetized by depositing the solution in close proximity to the nerve at the foramen ovale. The intra-oral approach to this point is made by inserting the needle through the buccal tissues, midway between the

of the procaine solution, has been found to be sufficient for plastic surgery of the head and neck. The character of the wound, the structures involved and the condition of the patient will largely determine the procedure.

INFILTRATIVE ANESTHESIA

Many patients who have wounds of the face can be properly anesthetized by means of infiltration with a solution of *procaine* and *epinephrine.* The 1 per cent solution is more desirable for subcutaneous injections about the face than a weaker solution because, when the stronger solution is employed, smaller amounts can be used, thus avoiding distortion of the structures. Some wounds preclude this procedure because of the deep structures involved or because of existing infection. Blocking of the nerve trunks or branches at some distance from the operative field is then more desirable. Wounds involving the nose, orbit, or ear often require combinations of both infiltrative and deep block anesthesia. Likewise, combination of infiltration and block anesthesia will be necessary for surgical procedures about the jaws. Wounds of the tongue and floor of the mouth require both infiltration and block anesthesia. Anesthesia of the entire tongue and floor of the mouth can be secured by injecting each lingual nerve in the vicinity of the internal oblique line and alveolar process of the mandible and by infiltration of the base of the tongue, intra-orally or extra-orally. For the extra-oral method, the needle is inserted in the median line, between the lower border of the mandible and the hyoid bone, and the point of the needle is directed to the base of the tongue. The solution is deposited so as to infiltrate the entire width and base of the tongue while the needle is partially withdrawn and reinserted.

TOPICAL ANESTHESIA

In dealing with wounds of the nasal cavities, the anesthetic agent can be applied directly to the tissues by use of tampons or cotton applicators. Topical application of the anesthetic agent to the lateral and septal surfaces, in the vicinity of the entrance of their respective nerve supply, will anesthetize the intranasal structures. Solution of *cocaine* is most satisfactory for topical application. However, a 10 to 15 per cent solution of *procaine,* with *epinephrine,* usually will be satisfactory, provided the saturated applicators are maintained in contact with the tissues and the measures are repeated two or three times at intervals of five minutes. Topical application of the anesthetic agent will produce satisfactory intranasal block if properly done.

surface of the ramus. At this point 0.5 cc. of the anesthetic solution is deposited to anesthetize the lingual nerve. The needle is advanced distally, not penetrating the periosteum, to a total depth of approx-

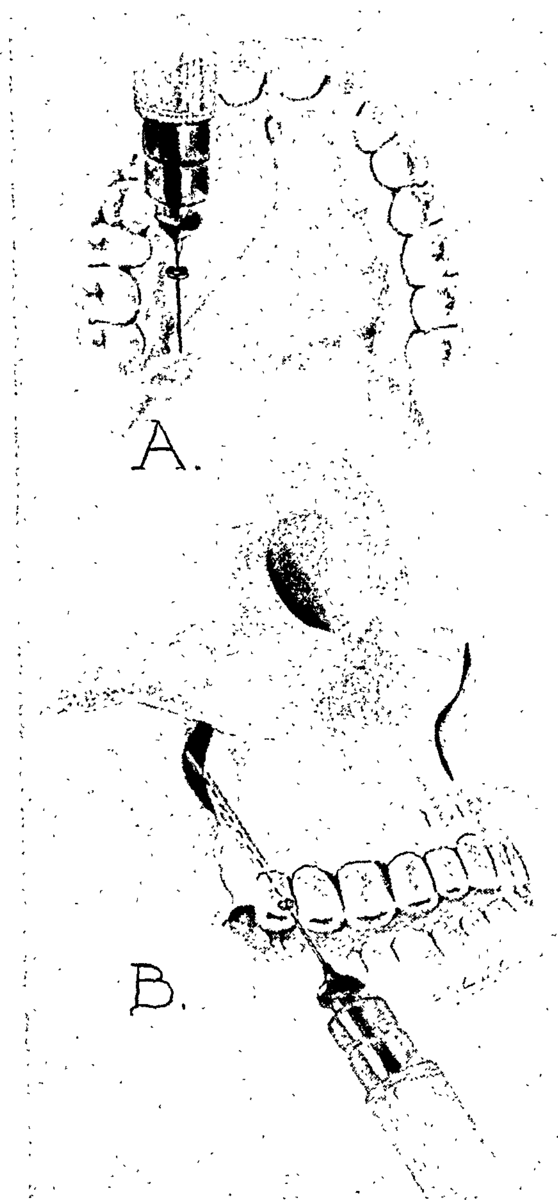


Fig. 247.—A, Palatal surface and greater palatine foramen; B, needle passing through pterygopalatine canal to foramen rotundum.

imately 2 cm.; its point is kept in contact with the medial surface of the ramus until the mandibular foramen has been reached, where 2 to 5 cc. of the solution is deposited (Fig. 249).

maxillary tuberosity and the coronoid process of the mandible; the point of the needle is directed slightly inward, upward, and backward to the greater wing of the sphenoid. At this point the depth should be noted by a marker on the needle. The point is then moved distally toward the foramen ovale by slightly withdrawing and reinserting the needle. Entrance to the middle fossa of the skull can be

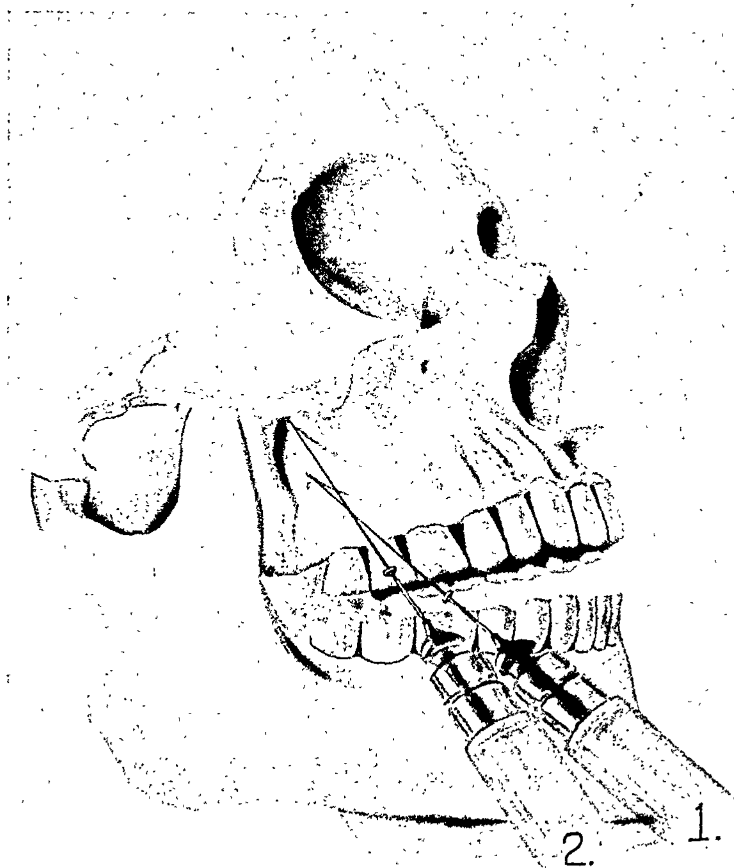


Fig. 246.—Position *1* illustrates the point of the needle in contact with the maxillary tuberosity, the site of injection for the posterior superior alveolar nerve. In position *2*, the angulation has been altered and the point of the needle advanced to the region of the maxillary division.

avoided by observing the relative position of the marker to indicate depth of insertion (Fig. 248).

The intra-oral approach to the inferior alveolar and lingual branches of the mandibular nerve is made by inserting the needle along the internal oblique line of the ramus of the mandible, approximately 4 mm. above the level of the occlusal plane of the lower molar teeth, with the bevel of the needle point in contact with the medial

Extra-oral Technic

An extra-oral route to the maxillary division of the trigeminal nerve is to insert the needle through the tissues below the zygoma and anterior to the coronoid process of the mandible, directing it inward, upward, and backward to the maxillary tuberosity. When the point of the needle reaches the tuberosity, the angle is altered so that the point can be advanced 15 mm. further, into the pterygopalatine

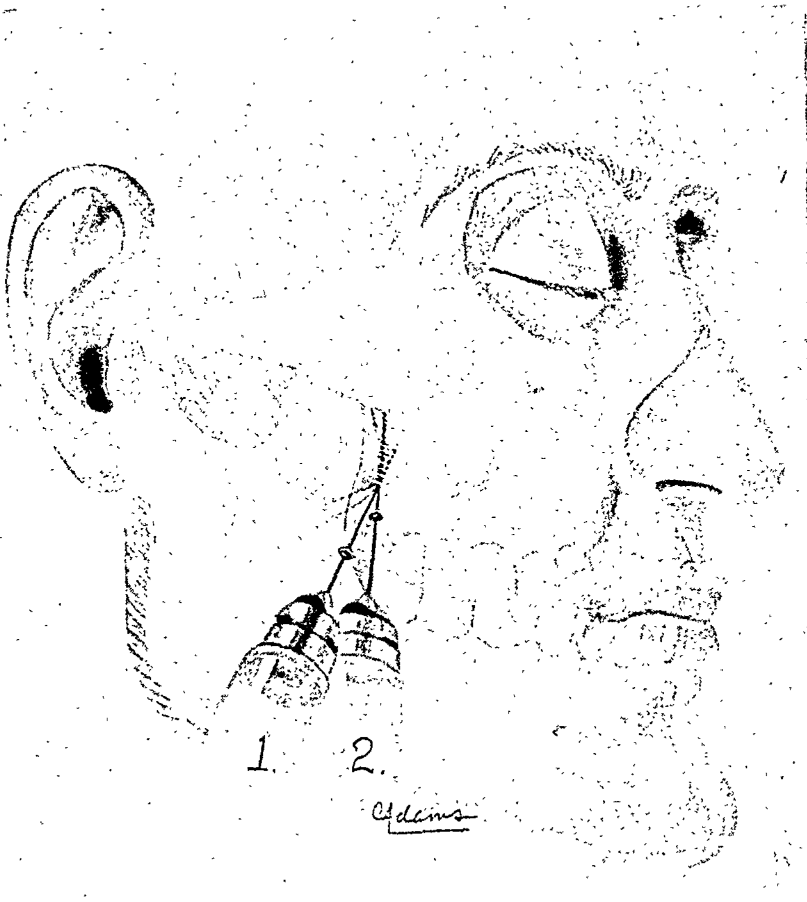


Fig. 250.—*1*, Point of needle touching maxillary tuberosity, site of injection of posterior superior alveolar nerve; *2*, altered position and point of needle advanced to pterygopalatine fossa.

fossa; the point of the needle is kept in contact with the posterior surface of the maxilla. The solution should be deposited at this point, in the vicinity of the sphenopalatine ganglion and of the maxillary nerve where it crosses the pterygopalatine fossa, from the foramen rotundum to the orifice of the infra-orbital canal (Fig. 250).

If entrance cannot be gained as has been described, owing to anatomic development or complications, with the mouth open and a

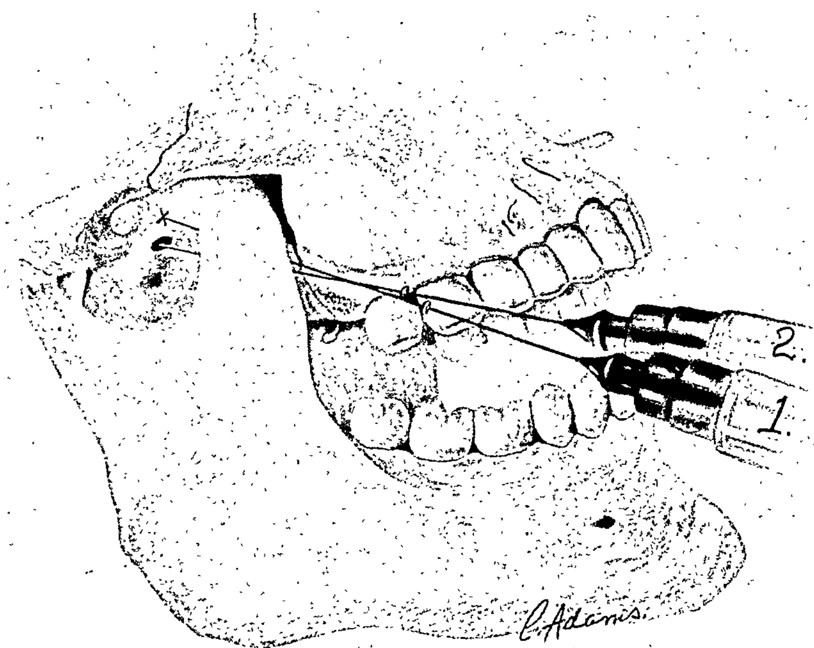


Fig. 248.—*1*, Needle point in contact with sphenoid; marker to indicate depth of insertion in position; *2*, altered position to reach foramen ovale.

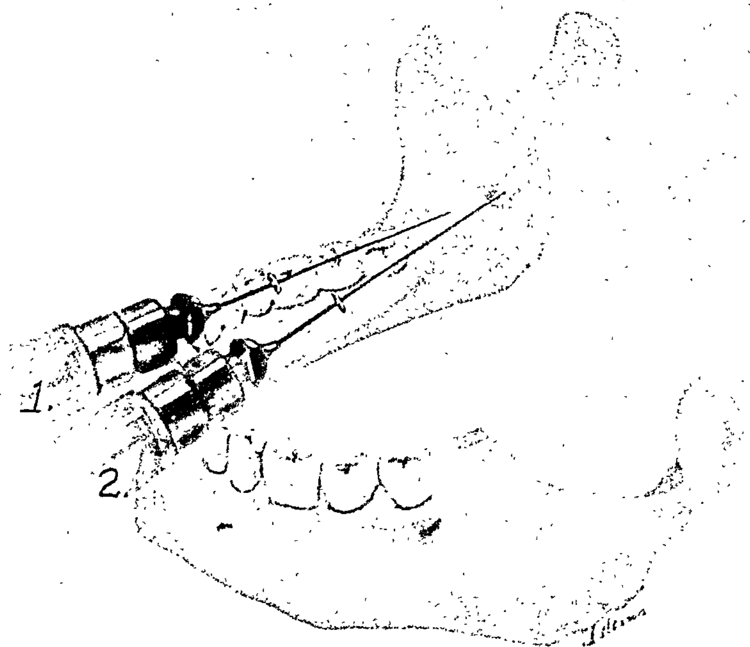


Fig. 249.—*1*, Insertion of needle along internal oblique line; *2*, position altered and point advanced to mandibular foramen.

bite block held securely on the opposite side, the needle can be inserted through the tissues under the zygoma and anterior to the tip of the coronoid process of the ramus of the mandible. Then it can be advanced to the maxillary tuberosity and pterygopalatine fossa, as previously outlined (Fig. 251).

Another extra-oral approach to the maxillary division of the trigeminal nerve is made through the orbit. With rubber marker set at

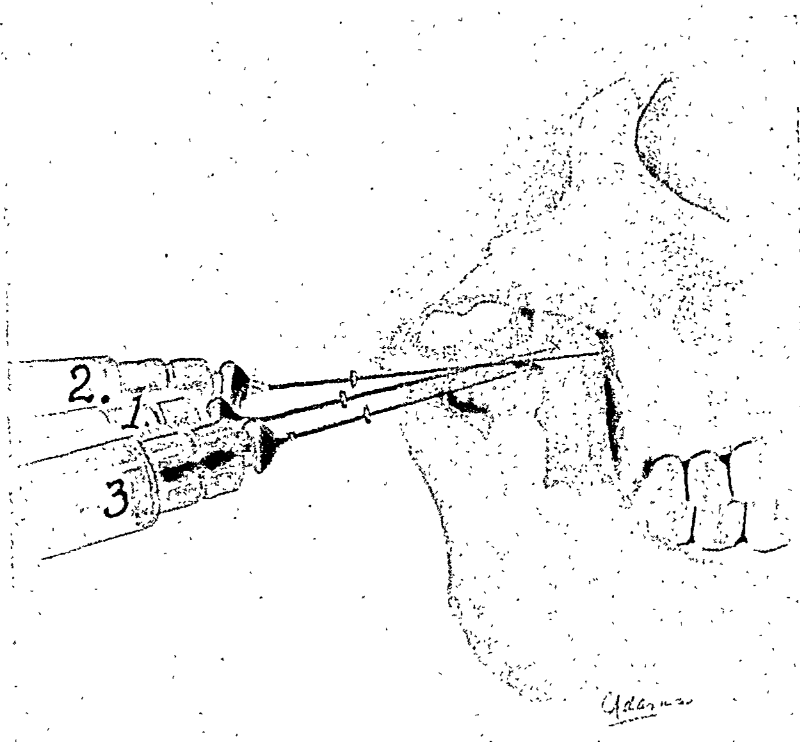


Fig. 253.—Anesthetization of the maxillary and mandibular divisions of the trigeminal nerve. In position *1*, the needle is inserted so as to touch the sloping under surface of the greater wing of the sphenoid (coronoid process of mandible is represented as transparent). In position 2, the needle is carried forward from position *1* into the pterygopalatine fossa for anesthetization of the maxillary division. In position *3*, the needle is carried backward from position *1* to reach the foramen ovale for anesthetization of the mandibular division.

55 mm., the needle is inserted at the lower and outer border of the orbit and is advanced inward and backward through the inferior orbital fissure to the vicinity of the foramen rotundum, 40 to 50 mm. (Fig. 252).

Still another approach for blocking this second division of the trigeminal nerve is to direct the needle through the tissues above the sigmoid notch of the ramus and beneath the lower border of the

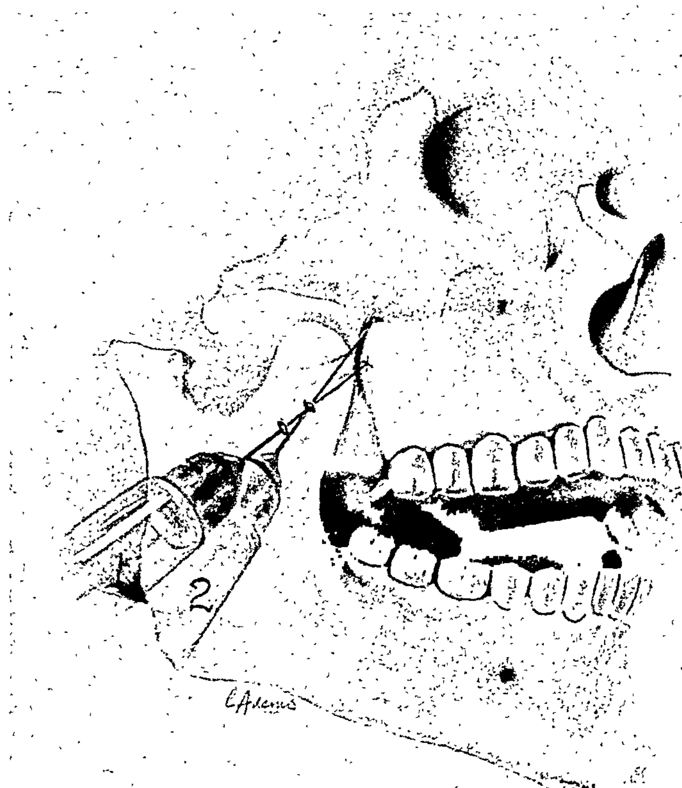


Fig. 251.—*Unnumbered syringe,* access to maxillary tuberosity improved by having the mouth open; *2,* altered position, with point of needle advanced to pterygopalatine fossa. Mouth prop securely held in position.

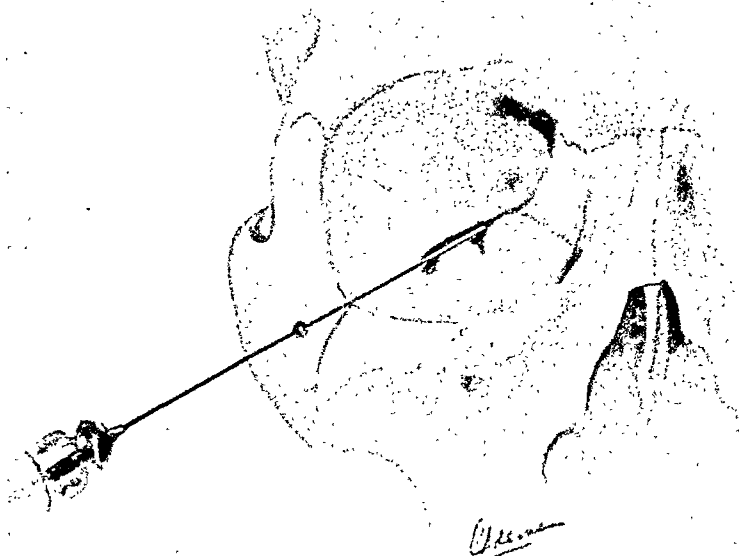


Fig. 252.—Orbital approach to region of foramen rotundum.

geminal nerve at the foramen ovale, as in the approach to the maxillary division, the needle is inserted through the center of the space outlined by the lower border of the zygomatic arch and the sigmoid notch. It is held at right angles to the surface of the skin in all directions and is caused to penetrate to a depth of 15 mm. The point of



Fig. 255.—Injection into supra-orbital notch and injection into infra-orbital foramen, with finger on infra-orbital margin to prevent entrance into orbit.

the needle is then directed slightly upward and inward and thrusts are continued until the sloping, under surface of the greater wing of the sphenoid is touched. By partially withdrawing and reinserting the needle, its point is then directed distally until it reaches the foramen ovale, where the solution is deposited. Entrance to the cranial cavity

zygomatic arch (mouth closed). The rubber marker or recorder should be placed on the shaft of the needle, 55 mm. from its point. The shaft of the needle is held at right angles to the surface of the skin in all directions and first is thrust to a depth of approximately 15 mm. The point is then directed slightly upward and inward, at an angle of 10 to 15 degrees; then the thrust is continued until the sloping under surface of the greater wing of the sphenoid is touched. The

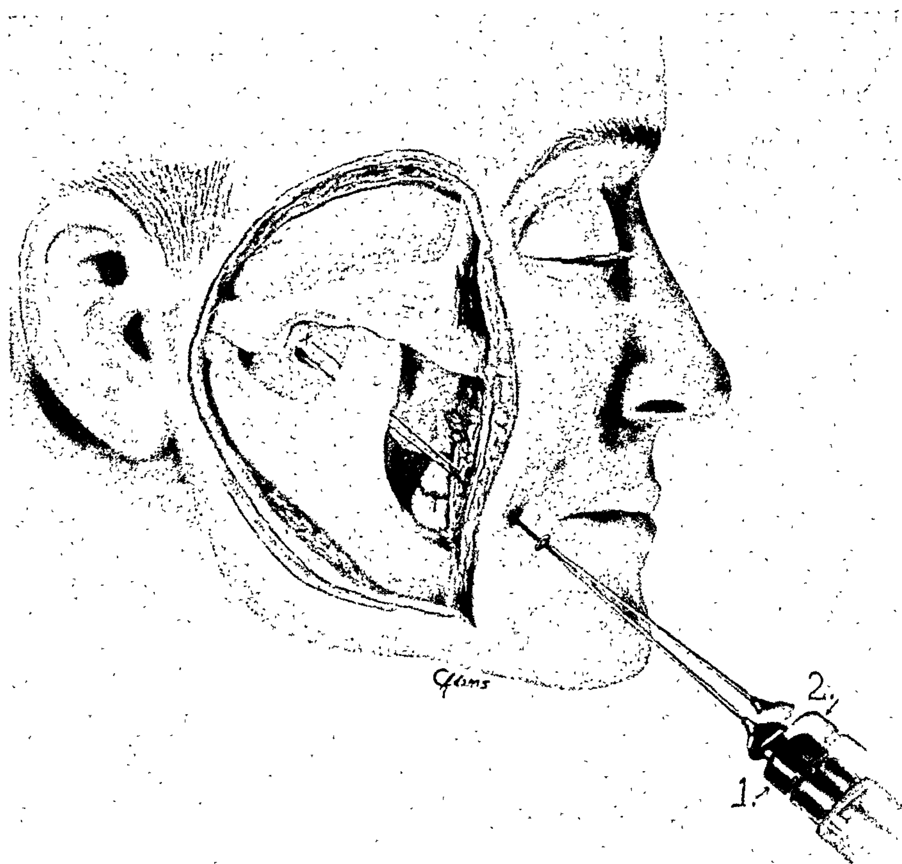


Fig. 254.—*1*, Needle inserted, with point touching under surface of sphenoid: *2*, altered position, with point at foramen ovale.

relation of the rubber marker to the surface of the skin must be observed; the needle should not be inserted more than 50 mm. By partially withdrawing and reinserting the needle, its point is then moved forward until it is felt to drop off into the pterygopalatine fossa. In a number of cases it will be found that the depth to this point does not exceed 40 or 45 mm. The solution deposited at this location will anesthetize the entire maxillary division (Fig. 253, *1* and *2*).

For extra-oral blocking of the mandibular division of the tri-

a point opposite the foramen. The orifice of the mandibular canal is at the junction of the middle and distal thirds of the ramus and on a plane slightly above that of the occlusal surfaces of the lower teeth.

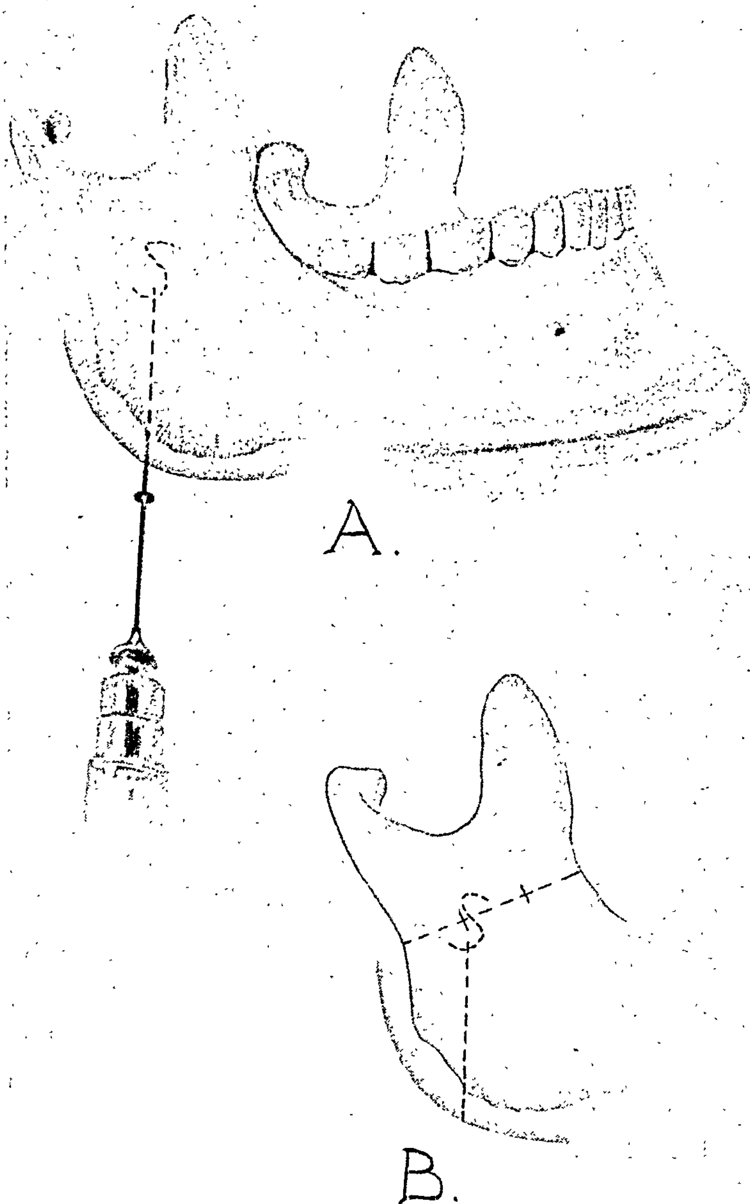


Fig. 257.—A, Extra-oral approach under angle of mandible; B, location of mandibular foramen and measurements for setting depth of insertion marker.

The measurement from this point to the point of insertion of the needle will serve as a guide for the adjustment of the rubber location marker on the shaft of the needle (Fig. 257).

can be avoided by observing the insertion marker. Insertion of the needle beyond 50 mm. is contraindicated (Fig. 253, *1* and *3*).

Another approach for anesthetizing the mandibular division of the trigeminal nerve is to insert the needle through the skin, approximately 1 or 2 cm. distal to the angle of the mouth; the point is directed through the tissues of the cheek and midway between the coronoid process of the mandible and the maxillary tuberosity, to the greater wing of the sphenoid. Penetration of the oral tissue must be avoided. The marker on the needle should be adjusted and observed, and the point should be withdrawn and reinserted distally, in

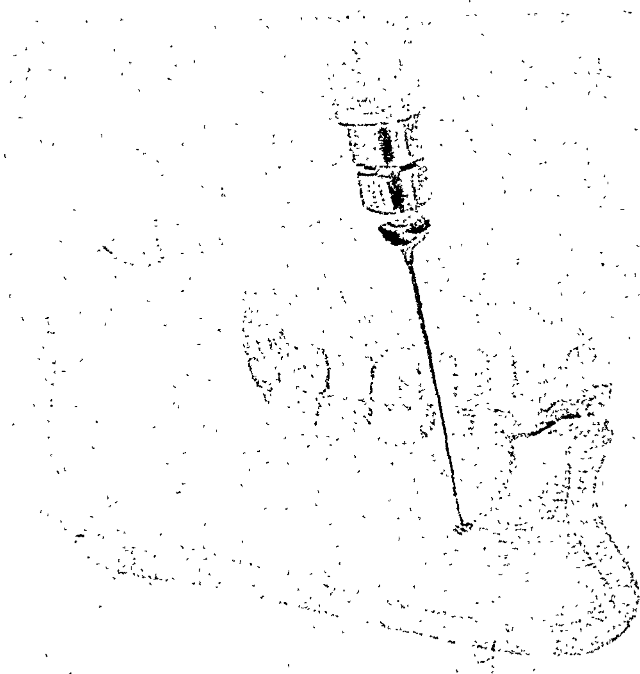


Fig. 256.—Approach to mental foramen from slightly distal angle.

the direction of the foramen ovale. Entrance into the cranial cavity can be avoided by checking the depth of insertion of the needle (Fig. 254).

Peripheral branches emerging from the supra-orbital notch, infra-orbital foramen and mental foramen can be anesthetized by injection at these points (Figs. 255, 256).

The extra-oral approach to the inferior alveolar nerve is made by inserting the needle from below the angle of the mandible and directing its point to the mandibular foramen. The definite depth of insertion of the needle can be predetermined by first outlining on the skin

CHAPTER XV

GENERAL ANESTHESIA*

THERE are few problems in anesthesiology that present a greater variety of technical difficulties than the production of safe and effective general anesthesia for operative procedures about the head. The surgical problem may be too complicated, however, to lend itself to regional anesthesia, and some degree of the safety factor may need to be sacrificed for the ultimate good done the patient.

PREOPERATIVE MEDICATION

It is known that certain factors will increase the reflex irritability of a patient, thus making anesthesia more difficult to induce and maintain than if these factors are absent. Of the factors, pain and fear must be highly regarded. Both should be allayed by adequate premedication before induction is begun. Fever, by increasing metabolic activity, must be taken into account, for a patient whose temperature is increased will be more resistant to narcosis than one whose temperature is normal. Severe toxemia and shock will decrease the reflex irritability, and patients who are in either of these conditions will need less premedication than is usual.

Morphine

The best drug for use in preoperative medication is morphine. The dosage must be determined for each individual. Less morphine is given to the person undergoing general anesthesia than to a corresponding person who is to receive regional anesthesia. One-sixth grain (0.011 gm.) is an average amount for an average patient. It is of particular importance to give the morphine by hypodermic injection an hour to an hour and a half before general anesthesia is induced in order that the morphine may exert its maximal effect. The practice of giving morphine one-half hour before operation, or on call, not only is useless from the standpoint of making the induction easier, but may actually be harmful, because the maximal effect of the drug may be manifested when the patient is deeply narcotized,

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and the combined effect may be sufficient to cause respiratory arrest. When circumstances will not permit administration of the premedication at least an hour prior to operation, it is suggested that the morphine be given intravenously, that the drug be diluted with 5 cc. of distilled water, and that the solution be injected slowly (three or four minutes). The maximal effect of the drug is reached in about twenty minutes.

Barbiturates

The derivatives of barbituric acid are also useful in preoperative medication. They may be classified into the long-acting, medium-acting, and short-acting derivatives. Phenobarbital and barbital are good examples of the long-acting group, sodium amytal comes in the medium group, and the action of pentobarbital sodium (nembutal) and seconal is of short duration. Usually the shorter-acting drugs are used in anesthesia. It must be remembered that this group of drugs is also depressant to the respiratory center, and it is prudent to observe the effect of the barbiturate before giving a hypodermic injection of morphine to a patient. There is no contraindication to combining morphine and a barbiturate, but it is good practice to give the latter at least an hour before the morphine is given. One and a half to three grains (0.1 to 0.2 gm.) of nembutal or seconal is the average dose.

Scopolamine

The combination of a derivative of belladonna with morphine is an old one. Atropine is most frequently used; but in corresponding doses, it is not so effective as scopolamine. Scopolamine is preferred for most robust adults, because it exerts a psychic effect that aids in producing the tranquillity so important in reducing reflex irritability. Good rules are as follows: with 1/8 grain (0.008 gm.) of morphine, use 1/200 grain (0.0003 gm.) of scopolamine; with 1/6 grain (0.011 gm.), use 1/150 grain (0.0004 gm.); and with 1/4 grain (0.016 gm.), use 1/100 grain (0.0006 gm.). These doses of scopolamine are more effective in drying mucous secretions than corresponding doses of atropine, and this action is one of the reasons for using a drug of the belladonna group. The drug takes effect in fifteen to thirty minutes, but it is customarily given with the morphine. An individual is occasionally seen who shows signs of sensitivity to drugs of the belladonna group, as evidenced by a flushed face, circumoral pallor, rapid pulse, dilated pupils, and some excitement. These signs need cause no alarm, as they pass off in a short time, but it is well to re-

member that $\frac{1}{40}$ grain (0.0016 gm.) of *apomorphine* will effectively counteract these manifestations of sensitivity.

CHOICE OF AGENT

The anesthetic agents that are considered of sufficient worth to merit discussion are ether, tribromethanol in amylene hydrate (avertin), vinethene, cyclopropane, nitrous oxide, and pentothal sodium.

An agent that will produce anesthesia without having to be inhaled always appeals to the surgeon working about the upper air passages and head, because he does not have to be bothered with anesthetic paraphernalia in his operative field, or be annoyed by anesthetic vapors exhaled by the patient. One fact must be constantly borne in mind. No matter what the route of administration of a general anesthetic agent, the only way the patient can take in oxygen and give off carbon dioxide is through the lungs, trachea, and upper air passages. No method can be considered safe, no matter how efficient it is in producing good operating conditions, unless it provides for the free exchange of oxygen and carbon dioxide. This fact cannot have too much emphasis.

Ether

For prolonged operations under general anesthesia, ether holds its place, as it has for more than ninety years. It is far from ideal, but it is safest in inexperienced hands. Its vapor is annoying to the patient and surgeon, nausea and vomiting frequently occur on recovery, it is inflammable; but in spite of these disadvantages, its safety to patients, relative simplicity of administration, and adaptability to a variety of technics give it first consideration. The chief *contraindications* to using ether are: infection of the upper part of the respiratory tract, severe hepatic or renal damage, pulmonary conditions that will be made worse by irritating vapor, and severe diabetes.

Maintenance of Anesthesia.—Ether anesthesia can be maintained in a variety of ways during the course of operations on the head and neck. The *open drop method* will serve in many cases. If it is desirable for the anesthetist to be further removed from the site of operation, ether can be delivered from a vaporizing machine to a metal or rubber pharyngeal airway equipped with a nipple for attaching the rubber tubing. The same method can be used for delivering ether through a small rubber tube inserted in one or both nostrils, passing the tubes into the oropharynx. These methods, however, do not offer the advantages provided by the *endotracheal method* of ad-

and the combined effect may be sufficient to cause respiratory arrest. When circumstances will not permit administration of the premedication at least an hour prior to operation, it is suggested that the morphine be given intravenously, that the drug be diluted with 5 cc. of distilled water, and that the solution be injected slowly (three or four minutes). The maximal effect of the drug is reached in about twenty minutes.

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trachea. It may be inserted through the nostril, or through the mouth by the aid of a laryngoscope. When in place, anesthesia can be maintained by any means that provides an adequate concentration of ether. A simple and efficient method is illustrated (Figs. 258, 259). Ether vapor from an ether pump is delivered into one hole in the ether can, the second one is left open, and the tube leading from the endotracheal catheter is placed in the third hole. This is a modification of a *method described by Flagg.* Because an unobstructed airway is provided, the anesthetist may be entirely out of the field of operation. Gauze packs may be placed in the mouth to prevent aspiration of blood. Less ether fumes are exhaled directly toward the surgeon working in the region of the air passages.

Intravenous Anesthesia

General Considerations.—Many of the shorter operations can be done using intravenous anesthesia with *pentothal sodium* or *evipal.* The former has become the more widely used in recent years. Preoperative medication should be given as it is given before administration of agents by inhalation. Giving of barbiturates intravenously is contraindicated if patients exhibit respiratory difficulty from any cause. These agents should be withheld if patients are suffering from severe hepatic or renal disease, and in this regard, evipal is preferred to pentothal if the sulfonamide group of drugs is being administered in such quantity that the patient can be expected to be approaching a state of toxemia. If the interior of the nose or mouth is involved in the operation, it is safer not to use the method unless an endotracheal tube is inserted to provide an airway. The chief danger in the use of these agents lies in the temptation to entrust their administration to inexperienced persons. Respiratory arrest will occur swiftly with overdosage. Because of this, intravenous anesthesia should not be used unless the anesthetist is prepared to administer efficient artificial respiration. Equipment for giving oxygen should be at hand. Metrazol intravenously, given to effect, is valuable, but maintaining adequate oxygenation should be the first consideration. Mouth-to-mouth breathing may prove to be the lifesaver during the stress of the moment. It is best performed by inserting a pharyngeal airway or endotracheal tube (if the former, the nostrils should be held shut) and by forcing one's expiration into the patient's lungs rhythmically at a normal respiratory rate.

Administration.—*Pentothal sodium* is marketed in ampules, each ampule containing either 0.5 gm. or 1 gm. of the drug in powder form. The powder is dissolved in distilled water to make a 5 per cent or

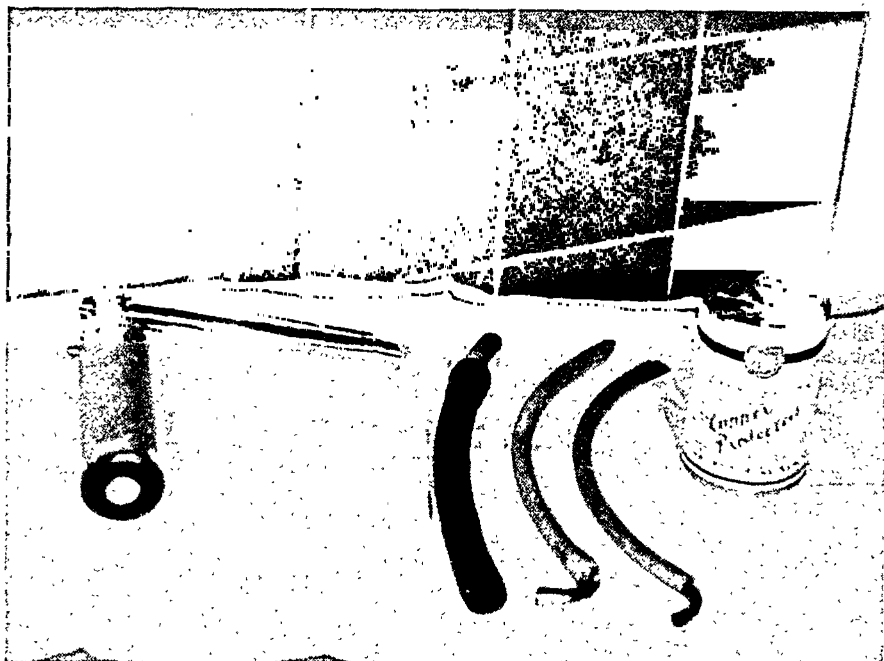


Fig. 258.—Apparatus for Flagg's "tin-can" method of endotracheal administration of ether.



Fig. 259.—Adaptation of Flagg method, using ether vapor from machine. Apparatus may be placed wherever convenient, and drapes placed over it.

ministration. Under deep surgical anesthesia, a firm rubber tube, molded in a slight curve, about 35 F. caliber, is passed into the

available at all times to combat respiratory insufficiency. Ephedrine sulfate, ¾ grain (0.049 gm.) intramuscularly, or two minims at a time intravenously, is valuable in case of overdosage. Coramine is also useful if given intravenously to effect; 5 to 10 cc. may be needed in exceptional cases. A thoroughly cleansing enema should be administered.

Contraindications.—Avertin is contraindicated if patients have difficulty in maintaining an adequate oxygen intake from any cause: diminished vital capacity, shock, blood or bleeding in the mouth, or swelling of the mucous membranes of the mouth or throat. Ulcerative colitis, and other inflammatory conditions of the rectum, or severe hepatic and renal disease are further contraindications.

Vinethene

For short procedures, such as débridement of wounds, removal of foreign bodies, painful dressings, extractions, etc., divinyl ether (vinethene) is a useful anesthetic agent. It is given by the open drop technic, or as a vapor. Because of its potency, a little goes a long way. The usual induction takes from thirty seconds to two minutes, and fair relaxation can be obtained. If the work to be done is inside the mouth, fairly smooth anesthesia can be maintained by dropping vinethene on gauze held over the nose of the patient, after induction has been completed in the regular way. The same care to avoid burns of the face must be observed as with ether, by using oil or cold cream. Vinethene is also useful in supplementing nitrous oxide anesthesia that is not giving adequate relaxation.

Recent laboratory investigation indicates that hepatic and renal damage can follow prolonged or repeated administration of vinethene and that while using oxygen with it is of value, it is believed safest to use the agent only for operations requiring less than one half hour to complete. Vinethene is inflammable.

Cyclopropane

Cyclopropane is a gas, capable of producing profound anesthesia and satisfactory relaxation in the presence of an abundance of oxygen. Induction is rapid and pleasant, and recovery nearly as quick as with nitrous oxide. Postoperative nausea is considerably less than with ether. There are no noteworthy physical conditions contraindicating its use, but the technic of administration requires more than ordinary ability on the part of the anesthetist. It must be given by the carbon dioxide absorption system because of its inflammability and cost. For surgery of the head and neck, cyclopropane is best given

2.5 per cent solution, the latter being preferable. Ampules of evipal contain 1 gm. of the drug, which is dissolved in distilled water to make a 10 per cent or 5 per cent solution. Somewhat smoother inductions are the rule with pentothal sodium than with evipal. A vein in the antecubital fossa or forearm is usually chosen and is entered with a 22-gauge needle. Various types of apparatus have been described to facilitate the administration, but a 20-cc. syringe with an eccentric tip secured to the forearm with adhesive tape is satisfactory. The drug always should be given in fractions—the older method of single injection is unsafe. The exact rate of injection varies with the individual patient and the needs of the operation, and so is dependent on experience, but caution should be the watchword. It should rarely be necessary or advisable to use more than 1 gm. of the drug, particularly if equal parts of nitrous oxide and oxygen are given simultaneously, as recommended by Lundy. Either face mask (BLB type) or a 12 to 14 F. nasal catheter can be used for administration of the gases, which should flow at the rate of 4 to 8 liters per minute. Relaxation of the muscles of the jaw occurs early, and an assistant should be assigned to maintain a clear airway if the endotracheal technic is not used.

Tribromethanol in Amylene Hydrate (Avertin)

Administration.—Avertin is not used as for complete anesthesia; but in combination with regional anesthesia, gas, or ether, it offers certain advantages that entitle it to consideration as a valuable agent in maxillofacial surgery. A single dose is given by rectum twenty minutes to half an hour before operation, and patients go to sleep without excitement in five to ten minutes when an adequate amount is administered; 80 mg. per kg. of body weight rarely should be exceeded. If an anesthetic agent, given by inhalation, is to follow, $\frac{1}{150}$ to $\frac{1}{100}$ grain (0.0004 to 0.0006 gm.) of atropine sulfate by hypodermic injection should precede the avertin. It will be found that inductions will be easier, and less of the agent that is to be given by inhalation will be needed. The field of usefulness of nitrous oxide or regional anesthesia will be increased. Postoperative nausea is decreased as a rule. However, disadvantages are also attendant. The period of recovery is prolonged, and there is considerable respiratory depression. This, many believe, increases the incidence of respiratory complications. The magnitude of the nursing problem is increased, because the patient cannot be left alone from the time the avertin is given until consciousness is regained—sometimes a matter of several hours. Relaxation of the muscles of the jaw is profound, requiring close watch to prevent obstruction of the air passages. Oxygen should be

available at all times to combat respiratory insufficiency. Ephedrine sulfate, ¾ grain (0.049 gm.) intramuscularly, or two minims at a time intravenously, is valuable in case of overdosage. Coramine is also useful if given intravenously to effect; 5 to 10 cc. may be needed in exceptional cases. A thoroughly cleansing enema should be administered.

Contraindications.—Avertin is contraindicated if patients have difficulty in maintaining an adequate oxygen intake from any cause: diminished vital capacity, shock, blood or bleeding in the mouth, or swelling of the mucous membranes of the mouth or throat. Ulcerative colitis, and other inflammatory conditions of the rectum, or severe hepatic and renal disease are further contraindications.

Vinethene

For short procedures, such as débridement of wounds, removal of foreign bodies, painful dressings, extractions, etc., divinyl ether (vinethene) is a useful anesthetic agent. It is given by the open drop technic, or as a vapor. Because of its potency, a little goes a long way. The usual induction takes from thirty seconds to two minutes, and fair relaxation can be obtained. If the work to be done is inside the mouth, fairly smooth anesthesia can be maintained by dropping vinethene on gauze held over the nose of the patient, after induction has been completed in the regular way. The same care to avoid burns of the face must be observed as with ether, by using oil or cold cream. Vinethene is also useful in supplementing nitrous oxide anesthesia that is not giving adequate relaxation.

Recent laboratory investigation indicates that hepatic and renal damage can follow prolonged or repeated administration of vinethene and that while using oxygen with it is of value, it is believed safest to use the agent only for operations requiring less than one half hour to complete. Vinethene is inflammable.

Cyclopropane

Cyclopropane is a gas, capable of producing profound anesthesia and satisfactory relaxation in the presence of an abundance of oxygen. Induction is rapid and pleasant, and recovery nearly as quick as with nitrous oxide. Postoperative nausea is considerably less than with ether. There are no noteworthy physical conditions contraindicating its use, but the technic of administration requires more than ordinary ability on the part of the anesthetist. It must be given by the carbon dioxide absorption system because of its inflammability and cost. For surgery of the head and neck, cyclopropane is best given

by the endotracheal method. Its use, therefore, is limited, but if the services of skilled anesthetists are available, it is one of the most valuable agents for anesthesia by inhalation.

Nitrous Oxide

Nitrous oxide is the pioneer among anesthetic gases, earning its place because it produces quick anesthesia, with quick recovery, and a minimum of nausea. It is noninflammable, unless combined with cyclopropane, vinethene, or ether. Its chief disadvantage is its relative impotence, and the need for a high concentration of the gas at the expense of the oxygen requirement of the patient. If nitrous oxide is selected as the agent in a given case, preoperative medication should be greater than with other agents. Avertin in small doses of 40 to 70 mg. (0.04 to 0.07 gm.) per kilogram of body weight will be of value. Percentages of oxygen below 15 per cent should not be permitted. In skilful hands, much can be done under nitrous oxide anesthesia, but for the inexperienced, some other agent should be chosen, or used in combination with the gas rather than risk injury to the patient through anoxemia.

POSTOPERATIVE CARE

The period of recovery from general anesthesia requires good nursing care, with particular attention to maintenance of unobstructed breathing. If blood or vomitus can conceivably enter the trachea in the course of emergence from anesthesia, the patient should be placed in bed on his side in the Sims position, with the under arm extended to support the head. A pharyngeal airway should be left in place until the danger of obstruction from dropping back of the tongue has passed. A suction machine, equipped with both a mouth suction tube and a nasal catheter, should be at hand in the recovery room. Body temperature must be maintained by adequate covering, and all draughts must be avoided. Pulse and respiratory rate should be determined frequently. When these conditions are fulfilled, the incidence of postoperative complications following operations on the head or neck is one of the lowest in all types of surgery.

INDEX

INDEX

26